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ABSTRACT

This publication is the result of a comparative study of environmental education programs at the university level throughout Europe. It includes a brief summary statement at the beginning of the text and then proceeds to a more detailed explanation, citing specific examples. Topics for consideration encompass labor market considerations, undergraduate and postgraduate study, course content, teaching methods, evaluation of programs and students, methods of integration, and institutional organization. An attempt is made to classify the programs of study available. The author also cites recommendations for cooperation in the areas of curriculum development, environmental education information, student and staff exchange programs, regional centers, practical work experience, and teaching aids. Three appendices include references, selected examples of programs, and a specific example of a course on environmental problems for psychology students at Lund University. (MA)

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environmental education at university level

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ENVIRONMENTAL EDUCATION AT UNIVERSITY LEVEL

by

Lars EMMELIN

University of Lund (Sweden)

COUNCIL OF EUROPE
STRASBOURG
1975

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The Council for Cultural Co-operation was set up by the Committee of Ministers of the Council of Europe on 1 January 1962 to draw up proposals for the cultural policy of the Council of Europe, to co-ordinate and give effect to the overall cultural programme of the organisation and to allocate the resources of the Cultural Fund. It is assisted by three permanent committees of senior officials: for higher education and research, for general and technical education and for out-of-school education. All the member governments of the Council of Europe, together with Finland, Spain and the Holy See are represented on these bodies[1].

In educational matters, the aim of the Council for Cultural Co-operation (CCC) is to help to create conditions in which the right educational opportunities are available to young Europeans whatever their background or level of academic accomplishment, and to facilitate their adjustment to changing political and social conditions. This entails in particular a greater rationalisation of the complex educational process. Attention is paid to all influences bearing on the acquisition of knowledge, from home television to advanced research; from the organisation of youth centres to the improvement of teacher training. The countries concerned will thereby be able to benefit from the experience of their neighbours in the planning and reform of structures, curricula and methods in all branches of education.

Since 1963 the CCC has been publishing, in English and French, a series of works of general interest entitled "Education in Europe", which records the results of expert studies and intergovernmental investigations conducted within the framework of its programme. A list of these publications will be found at the end of the volume.

Some of the volumes in this series have been published in French by Armand Colin of Paris and in English by Harraps of London.

These works are being supplemented by a series of "companion volumes" of a more specialised nature to which the present study belongs.
General Editor:

The Director of Education and of Cultural and Scientific Affairs, Council of Europe, Strasbourg (France).

The opinions expressed in these studies are not to be regarded as reflecting the policy of individual governments or of the Committee of Ministers of the Council of Europe.

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0.1 INTRODUCTION

This study was conducted in the spring and summer of 1974. It is based on material collected by me during visits to a number of programmes in some of the member countries of the Council of Europe, on material collected by the Environmental Studies Programme at the University and Institute of Technology in Lund, Sweden and on material collected by the Centre for Educational Research and Innovation (CERI) of the OECD. The study was designed to complement rather than duplicate the simultaneous efforts of the CERI. I have therefore concentrated on programmes based mainly on the natural sciences and on collecting material on the educational methods and organisation of such programmes. I have seen it as an important task to try to pick up good ideas from the daily work of environmental educators and describe these.

Not included — or only marginally — are programmes which are in one or more of the categories: technical education, social science based programmes dealing with the urban environment or social relations (1.2.2); traditional education for the planning professions.

At a meeting of experts in Strasbourg in the autumn of 1973 it was decided that the method of study should be visits to a number of programmes. Sending out a questionnaire to institutions of higher education was considered but decided against. Comparing my first-hand experience of a number of programmes, with the picture of these same programmes which one can get from attempts at surveys made by several international organisations (e.g. the Council of Europe or CERI), strengthen me in my own conviction of the wisdom of this decision.

I was greatly aided in the choice of programmes to visit by the experience of the members of the committee of experts. It is obvious that the choice is a subjective one. The use of other material is meant to offset the restrictions imposed by available time and funds for the first-hand studies. Although many persons placed their expertise at my disposal, the responsibility for the choice of places to visit is of course mine.

Although visiting a programme in person is a very good first measure to ensure correctness of the material, it is obvious that there must be misunderstandings and incorrect information in my interpretations. The total material used in this study weighs 48 kg and is in nine languages. I apologise for any misrepresentations that occur and would be most grateful to hear about them.

Thanks are due to so many persons that they cannot be listed here. At all the places I visited I enjoyed the privilege of drawing on the time of very busy people. For this and for hospitality, help in practical matters and many such things that made this study personally very interesting and rewarding to me my warmest thanks are due.

0.2 A NOTE ON TERMINOLOGY

Terms such as interdisciplinary, multidisciplinary belong to the educational jargon used in this study. I have tried to follow strictly the suggestion made by Duguet (1973) for the use of the terms: "discipline", "pluridisciplinary", "multidisciplinary" and "interdisciplinary". Used in this way the terms seem to me to be meaningful:

"discipline — a specific body of teachable knowledge with its own background of concepts, procedures, and methods.

multidisciplinary — juxtaposition of various disciplines, sometimes with no apparent connection between them.

pluridisciplinary — juxtaposition of disciplines assumed to be more or less related.

interdisciplinary — an adjective describing the interaction between two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration . . . over a wide field."

Although the differentiation between multidisciplinary and pluridisciplinary is a subjective one I find these concepts useful as descriptive terms and in the individual cases I do not think that there is a great deal of doubt what is meant. A philosopher might think otherwise.

I have used "interdisciplinary" as a value judgement to indicate that I think a measure of integration has occurred. I have no hope that in individual cases agreement will be as easy.

I have not used the proposed term "transdisciplinary" (= establishing a common system of axioms for a set of disciplines) although I have discussed briefly the extent to which I believe it likely that integration can be carried. In the section on unifying concepts the problems of transdisciplinarity are discussed.

The term "programme" has been used as a general noun to denote all sorts of collections of courses offered as a planned whole. It is also used loosely to denote the variety of organisations giving environmental education in accordance with some kind of plan.

"Natural ecology" and "energy consumption" are two terminological horrors which I have used for lack of any stringent substitutes. "Natural ecology" is used to denote what the biologist would simply call "ecology" in discussions where terms such as "human ecology" or "social ecology" also occur.

Although "energy consumption" is a violation of the laws of thermodynamics, the more stringent "energy conversion" has a more limited meaning to most people i.e. the conversion of one form of

energy into another for the purpose of distribution or storage; chemical energy into electrical in a power plant etc.

"Europe" has been used to denote continental Europe plus Britain and Ireland; "Northern Europe" to denote Germany, the Scandinavian countries and Finland.

Finally one of the few deficiencies of the English language has forced me to decide on the gender of "student". My arbitrary choice has fallen on the feminine.

0.3 CONCLUSIONS OF THE STUDY

This study is mainly descriptive. Analysis is tentatively offered. Points are raised mainly for discussion since very few statements of results or trends in environmental education can be made with any certainty.

I have added a section of conclusions (0.3.0) to this document after discussions have been held at Strasbourg in December 1974. The conclusions reached by a group of experts on various aspects of environmental education would seem to me to be much more worth putting on paper than a summary of my discussion in this paper.

The environmental education here described is mainly based upon the natural sciences. In terms of the resource demand model (1.2.4) the programmes deal mainly with analysis of the resource side of the problem. Quoting the introduction to one programme — "... the whole collection of sciences concerned with the constraints placed on man's activities by the nature and structure of planet earth, with the effects man has on his environment..." — and adding that the basic groups of sciences in fact used are the natural sciences with others called in as ancillary is a fair representation of the core of most programmes.

0.3.1 *Labour market considerations*

Programmes typically have their origin within the institutions of higher education with little direct outside influence from government or administration involved in either conception or operation of programmes. Motivating forces seem to have been a perception of the "environmental crisis" or some component thereof and the need for new types of education needed to provide new bases of knowledge for administration, planning, conservation, pollution control etc.

In only a few cases are there directly recognisable positions for which a specific education has been created. Two examples were brought to my attention at the Strasbourg meeting: 1. education for chief health inspectors at the new Finnish university of Kuopio, and 2. the labour market created by a new law requiring German industries to employ a special "emissions officer". In spite of several projections for large new labour markets requiring totally new types of education most universities have adopted a much more realistic attitude. There is a great need for new knowledge and skills in planning, administration, pollution control etc. but graduates from programmes will have to compete in an existing labour market with students from other types of education.

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* Two examples were brought to my attention at the Strasbourg meeting: 1. education for chief health inspectors at the new Finnish university of Kuopio, and 2. the labour market created by a new law requiring German industries to employ a special "emissions officer".

The approach used differs greatly between programmes. Among deciding factors are: national and local institutional structure (2.2—2.3), target group for the education (1.2.1; 1.2.3), general attitude towards education (1.3), level within the university system (1.4.4; 1.4.5; 1.6), competence of contributing organisations (1.2.2; 2.1; 1.4.6—1.4.8).

0.3.2 *Undergraduate education*

In undergraduate education the programmes serve as a broad base for further specialisation and vocational training. The motives for such broad undergraduate education are in some cases of a very general, educative nature (1.3). The environment presents a good point of departure for an education which can combine a number of sciences. The education should provide the student with a sound basis for later specialisation but also with skills and attitudes which make continued life-long learning natural. This is arguably a most important task for any undergraduate education. Some programmes have narrowed down this objective to one of providing a background for entry into planning, conservation, natural resource management (1.4.7—1.4.8) or teaching (1.4.9).

0.3.3 *Post-graduate programmes*

In post-graduate programmes, recurrent education etc. the objectives are either to provide what in a sense is a specialised education aiming at a sector of environmental work, or to give a broad overview. Both types of programme must be judged in relation to an individual student's previous and later studies, work experience etc. The broad programmes have as their objective to provide a basis for communication with and between specialists working in fields of environmental relevance (1.4.4). These tend to be multidisciplinary. They face a measure of lack of understanding from funding bodies. Programmes with basically this approach but in combination with a concentration on a pluridisciplinary preparation for work in planning, land management and conservation seem to be more readily acceptable to administrators.

The conclusions of the general discussion (1.0—2.7) are in summary:

Integration of environmental matters remains neglected (1.4.1). In view of the low total number of students taking any form of environmental course (1.4.2) this neglect is serious for both quantitative and qualitative reasons. The failure to integrate environmental matters into existing education wherever relevant extends to the school system.

Although overview courses have several useful functions to perform — motivation for further studies, creating awareness etc. — it seems appropriate to warn against the tendency to use the existence of such

courses as an excuse for no further action in curriculum reform. This danger seems particularly apparent in higher technological education (1.4.1).

Environmental education is only one of many forces driving towards longer education. At the same time other forces — both economic and the problems created by the rapid development of scientific knowledge — tend to work in the opposite direction. This would theoretically favour a combination of undergraduate education, which imparts basic skills and attitudes, and recurrent education. An increased interest by universities in designing recurrent education programmes is noticeable and increasingly demanded by society. However it would be advantageous if higher education were seen as a whole and undergraduate education designed to fit into the system. The aims of recurrent education would seem to have to be in a sense remedial a long time yet (1.4.4.; 1.4.5).

The education of decisionmakers is generally neglected not only in the environmental area — although it could be argued that nowhere is it more apparent and dangerous. In this area as in all forms of recurrent education institutions of higher education should play a more active role. Co-operation with outside agencies, voluntary groups etc. must be sought to complement the expertise of the universities and to open new channels of communication (1.4.10; 2.7).

These conclusions and much of the discussion raises several points about funding of both programmes and students which are outside the scope of the study. They can however not be neglected in an analysis of the possibilities for implementing my proposals.

A critical factor to the success of environmental programmes and to whether they can make an impact on society is the entry to key professions. The situation which exists in some countries where entry into e.g. planning, administration etc. is via a small number of existing, well defined educations would seem to be extremely dangerous. A wider entry into professions makes contributions from many sources possible. In particular the planning professions and the school system should be open to people of varying backgrounds to provide diversity.

0.3.4 *Course content*

Although most programmes are based on the natural sciences (1.0; 1.2.4) both multi- and pluridisciplinary environmental education brings in economics, law, social and behavioural sciences. There is a common tendency for these contributions to be of a utilitarian nature. Needs have mainly been specified by natural scientists, responsible for the courses. The analytical side of these sciences therefore tends to be neglected (3.5.1).

The use of ecology as the intellectual basis for environmental education is almost universal. Exceptions do occur — e.g. geography

at East Anglia — but in general ecology is central to programmes. In the discussion of course content I raise some doubts about the exact position of ecology in programmes. It would seem that the practical contribution ecology can make to regional planning is rather unclear. This is not saying that ecology is not useful as a basis for conservation or as an intellectual framework for environmental education (3.4).

Of the deficiencies, with regards to content, the limited contributions from social sciences and economics were most often pointed out by students and staff.

0.3.5 *Teaching methods*

The study contains a fairly large descriptive section on teaching methods. In general it seems fair to state that most programmes show a great willingness to experiment and innovate in the area of methodology. Limited time, staff and financial money has led to more traditional teaching than considered optimal by the staff. At the same time environmental education is a good example of an area where the use of the traditional academic lecture is demonstrated. Parts of most programmes aim at giving an accurate and up-to-date overview of a wide field for which purpose the traditional lecture is well suited.

0.3.6 *Evaluation of programmes and students*

The examination systems would seem to be a major obstacle in many programmes in realising the behavioural goal of teaching and stimulating group work. A willingness to experiment with non-traditional methods for assessment is shown by most programmes but students are mainly evaluated singly and on factual knowledge (4.4).

Evaluation of programmes seems little developed partly because of the short time many have been operating. The press of daily work and the limited resources, but also a measure of lack of interest, seem to be further explanations for this. The behavioural goals of programmes — particularly such as "giving students a background for life-long learning and adaptation in a changing world" — are hardly assessed. This is not unique to environmental education (4.11; 4.7.6).

0.3.7 *Methods of integration*

Opinion differs about the existence of a science of the environment. Most people involved in programmes do not seem to think that such a unified science yet exists but many express a belief in the evolution of one. The means of achieving this quoted are several: using unifying concepts such as energy (3.3.1) or from ecology (3.4); by way of methodology such as systems theory and analysis (3.3.2); by research (2.6) or practical work (4.8.6).

In general the opinion seems to be that, if an environmental science is to develop, it is going to be through research rather than teaching (2.6). Including students in research teams, projects, field work etc. is therefore important as a method for integration in most programmes (4.7; 4.8).

The use of unifying concepts has already been mentioned and is stressed as important in most programmes (3.3). The traditional education of staff members is a serious problem in integration and sometimes results in the integration being left to students. It seems realistic to do so. Students should however be informed of the practice since they tend to confuse it with lack of coordination.

There is a danger in integration, which is seldom discussed. The temptation to oversimplify in order to present a coherent picture is great. The holistic approach runs the risk of being simplistic (5.5).

Section 5 sums up some of the points on integration brought out in the study.

0.3.8 *Institutional organisation*

In order to achieve the goals of environmental education a certain amount of reorganisation seems necessary in most universities. Ideally the body responsible for the programme should be in control of resources, have its own staff and do its own research. A school of environmental studies (2.1.1) would seem ideal. In most systems the autonomy of the organisation cannot be that great. A small co-ordinating body which is provided with sufficient resources for drawing upon departments within the university but also buying teaching from agencies outside seems a workable compromise (2.1). Putting the teaching under one or two existing departments seems less favourable in that the programme will be dominated by the competence of too small a group of people. This conclusion seems less valid in pluridisciplinary programmes of which the conservation programmes are the most important.

1.0 WHAT IS ENVIRONMENTAL EDUCATION?

A very pragmatic approach was adopted for this study — to look at a number of programmes that claimed to be concerned with environmental education. Since programmes have great variations in approach, it follows that finding the least common denominator of programmes is not a good definition of the area under study, as the reader can easily see from an examination of the specimens exhibited in appendix 1.

However the following quotation from the information on the Plymouth programme * may — with some reservations that will appear — be considered to indicate what is dealt with in a fair number of the environmental education programmes studied:

"Environmental Science is not yet a single subject. It is the whole collection of sciences concerned with the constraints placed on man's activities by the nature and structure of planet earth, with the effects man has on his environment by his activities, and with the economic and sociological possibilities and implications of controlling some of these activities. It therefore includes geology, geography, much of biology, some aspects of chemistry and physics; and borrows heavily from sociology, economics and mathematics for many of its methods and concepts."

This definition is no better or worse than any other that occur in my material. Serious objections could be raised against almost all the statements from programmes that would superficially seem to be well described by it. The situation in Europe with regards to a definition is, even so, less confusing than that of North America, as is apparent from material collected for a recent conference on environmental education arranged by the OECD. Neither previous Council of Europe conferences nor this conference have wasted time on trying to produce an acceptable definition of environmental education.

1.1 General reasons for environmental education

Programmes have their origin in a perception of what may loosely be referred to as the "environmental crisis" or some large or small component problem thereof.

The analysis of the problem, the necessary skills, disciplines, educational methods, prospective student category, suitable level in the educational structure etc., which each programme has arrived at, define the programme, as does its institutional origin, organization, staff etc.

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* Programmes are normally referred to by the use of the name of the place in which the educational institution is located, by an abbreviation etc. These are given in appendix 1 to which frequent reference must be made since details referred to in the text are often not given elsewhere.

Again the variations are enormous and examples will be given, in preference to an attempt to construct a structure into which to try to fit everything.

It is interesting to note that although "the environmental crisis" is the raison d'etre for programmes some are extremely shy of acknowledging the existence of such a crisis. In their effort to appear objective, scientific and trustworthy they go so far that one wonders what good reason they have for their existence — apart from perpetuating the departments which make up the programme.

1.2 Classification of environmental education

Four complementary ways of classifying environmental education will be given.

1.2.1 *According to strategy of introduction*

A. In looking at the university structure, four levels of environmental education which require different strategies of introduction and programmes of education can be recognised. (Emmelin, Johansson, Palmstierna 1968):

1. There is a need for integration of environmental aspects into most university subjects in a relevant context. This is for reasons both of quantity — special courses will not reach all or even a majoritiy of students — and quality: students should be taught to relate their specialised knowledge to environmental matters. This is most evident in some professions such as engineering, planning, administration. It requires changes in many curricula and a long term strategy of change (Emmelin, Johansson, 1972);

2. There is a demand for rather short, multidisciplinary overview courses open to large groups of students, people already in work (irrespective of previous background with regards to education). This requires co-ordination and some method of mass-production or co-operation with educational agencies outside the university if the aim is to reach other groups than those already at university.

3. There is a need for training of specialists in existing disciplines. A strategy of bringing these to work more on environmental problems may require stimulation of various sorts and introduction of specialised education.

4. Members of certain key professions (cf. C:c in Newbould's classification 1.2.3) require a training in environmental problems as a complement to their professional training. It goes beyond "the ability to converse" (C:c). A store of common knowledge and concepts as

a basis for communication is implied, as is the ability to co-ordinate the work of those experts which form a team to tackle a problem and to communicate the results of the work of experts to politicians, the public or other non-specialist audiences.

Variations on this classification appear in many places. Many do not approach the entire university system and therefore leave out level 1. The Berlin Institute of Technology states the needs for three kinds of engineering education on the environment, which corresponds to saying that all engineers should be subjected to level 1, a large proportion to level 4 and a smaller group to level 3.

Similarly the Institute of Technology in Vienna states as its aims in environment protection to give three types of education: broad introduction, specialised courses and a diploma for people with their primary degree (= A:4).

1.2.2 *According to categories of content*

B. Looking at the programmes for a definition of environmental education relating to content one might use the four broad categories recognized by Francis (1974 b):

i) "*environmental design*" which draws on aspects of architecture, town planning, landscape architecture, regional science and urban studies; ii) "*environmental health sciences*" which draws on aspects of the bio-medical sciences, public health and hygiene, sanitary and chemical engineering, occupational health and safety; iii) "*environmental conservation and management*" which draws on aspects of forestry, agricultural land use, countryside planning, water resources management, wildlife ecology, parks and outdoor recreation planning, minerals and energy development; iv) "*community and human environments*" which draws on aspects of human and social ecology; community organization and services, law, human rights, criminal justice, psychology, social work and personal counselling services.

Some comments seem appropriate in relation to these categories.

There is in my material a distinct tendency to try to combine health sciences and conservation and management (ii and iii). This is evident in both medium size programmes (ESP 40, Salford, Trondheim) of one or two semesters and the longer ones (Paris VII, Louvain) of three or more years.

A distinct effort to combine design and conservation and management (i and iiii) is also evident, not least in the British courses (Edinburgh, University College London, Plymouth).

Finally it is obvious that the many multidisciplinary overview courses that exist defy most attempts at such classification (Oslo, Amsterdam IWG, ESP 10 etc.).

1.2.3 *C. Groups that require environmental education*

Newbould (1973) recognises four groups which need university education on environmental problems; and therefore four roles for the universities:

"a. In training school teachers and others concerned with the training of school teachers, who will have to carry the main burden of the new environmental education.

b. In the education of the most influential sections of the population whether they be doctors, lawyers, politicians engineers, businessmen, scientists, technologists. They will form the vocal element of the general public who can participate effectively and knowledgeably in legislation and planning. Planners claim that they welcome public participation; it is a vital component of democracy. But it will not work unless the public are appropriately educated to understand the issues.

c. In the professional training of the so-called land-linked professions — farming, forestry, landscape architecture, planning, civil engineering, traffic engineering, architecture recreation management, social administration. The planning and management of resources including land is now so complex that it can only flourish as a team activity. The essential here is that the members of the team have sufficient common vocabularly and concepts to converse with one another.

d. In the training of ecologists and environmental scientists who will have responsibility for research and management activities directly related to the environment."

Regarding b, many programmes would probably like to see a wider role for the universities than just bringing environmental education to those sectors of the public which traditionally are educated at universities. Some programmes are exploring ways of non-traditional education and involvement in society.

On c there is no consensus cf. "specialist-generalist" controversy (1.5).

1.2.4 *Resource — demand model*

O'Connor in (a personal communication) suggests that environmental education can be seen in the perspective of a resource — demand model. Environmental problems can be studied either in the context of available natural resources — their characteristics, distribution, state variables etc. — or one can study man's demand on the natural resources. The former perspective requires a core of natural science with other subjects as complements whereas the demand aspect would be based in the social, economic and behavioural sciences.

Clearly the programmes in this study emphasize the resource aspect of environmental problems. This may partly be because of an origin in the natural sciences but also because to environmentalists the most obvious deficiency in the planning process today is the lack of background knowledge of natural resources.

Those programmes dealing with conservation in a wide sense (cf. 1.4.7) seem to be attempting a bridging of the gap between the two ways of looking at environmental issues.

1.3 The "liberal arts" approach to environmental education

There is one further approach to environmental education which is used in some experimental universities in Europe and North America. These take a number of general educational goals as the reason for teaching about the environment. Such goals may be those of Alfred North Whitehead "to stimulate the enquiry into parallel fields", an open attitude to continuous learning, combining analytical and synthetic ability etc. They have adopted "the process over content approach" (Francis 1974 a, cf. 3.1).

The environment is seen as especially suited to teach students particular attitudes and skills of investigation, synthesis and analysis. Examples of universities which have used this approach are the University of Wisconsin Green Bay (Weidner 1974), The Department of Man-Environment Studies at the University of Waterloo, Canada, (Francis 1974 a) and Roskilde University Centre in Denmark.

The School of Environmental Sciences at the Plymouth Polytechnic is the European example in this study which has adopted this approach — although clearly in combination with an analysis of what contents may be relevant to the study of environmental problems. Heath (1973) writing of the School states: "Environmental Sciences should replace the Arts and Humanities as educative subjects for future administrators. It is fitted for this role not only by its subject material but also by its breadth and demand on numeracy. The very complexity of the environmental systems being studied should develop that flexibility of thought necessary (but alas all too often lacking) in administrators."

This approach to education in innovative systems is interesting also in relation to the demand for more vocational orientation of higher education which is voiced mainly by administrators in many European countries.

1.4 Attempt at classification of programmes

In the appendix some programmes have been marked according to the three ways of grouping programmes given above — level in system, grouping of contents and type of students.

Not all programmes have been thus classified. I have sought to find representative examples, not to make a taxonomy of education.

1.4.1 *Integration into all subjects (A:1)*

To find out the degree to which environmentally relevant topics have been brought into subjects would require a different study from the present.

There are however some indications of the progress of this process of change. It is quite obvious that in the vast majority of cases it is just not occurring. Contributing factors may be that there is usually little outside pressure on the content of education from e.g. Ministries. At present there is however pressure on the length of post-secondary education in many European countries. This is not a situation in which environmental considerations are likely to be incorporated into curricula that are already over-full due to the development of disciplines. These problems are most acute in those educations where the need for integration of environmental education is greatest — engineering, planning, the education of economists (cf. 3.5.3 on economics).

Surveys of the environmental education at Institutes of Technology often show a great deal of activity which however usually refers to traditional courses on waste and effluent treatment, hydrology, water purification etc. There is no guarantee that e.g. waste water treatment courses have been modernised and given a reasonable component of limnology (cf. 3.4). Changes often refer to the creation of very small overview courses taken by a small percentage of students or to the establishing of new lines of study (Twente, Berlin) rather than the integration of environmental awareness into all lines of study. The Institute of Technology in Vienna aims at giving a common overview course to all engineering students. It is to be hoped that this experiment is carried on for some time regardless of curriculum problems.

In the UK there are other ways into the engineering profession than the type of education given by continental Institutes of Technology. Specialised Masters courses on top of a natural science education is one way. Graduates from the King's College programme could specialise in engineering in their post-graduate studies. Although this does not fulfil the requirements of integration dealt with in this section, it is an interesting example of the diversification of professional education (cf. 2.4).

1.4.2 *Overview courses* (A:2)

Multidisciplinary overview courses now occur in some form at most universities. There is wide variation in content and size — the

latter ranging from a few lectures to several weeks or some months. Examples in this study are Oslo, ESP 10, Leiden, Amsterdam IWG, Delft, Vienna, Trondheim. Although these courses are often quite large, a small proportion of the total student body of any university take these courses (3.2). Abillon (1973) estimated that less than 2 % of the total student body of Europe were exposed to environmental education in 1972. Allowing for increases since then I would estimate that the figure is still below 5 % of the students (cf. 3.2). Locally figures may be higher e.g. at the Danish College of Agriculture where approximately half the students get an overview course. This may alter the impact in certain countries on certain professions but does not alter the general conclusion that overview courses so far do not solve the problems of education of decisionmakers or the problem of remedial education discussed in 1.4.4.

1.4.3 *Education of specialists* (A:3)

Most of the work in this sector is outside the scope of this study. The activity of the Environmental Studies Programme at the University of Lund (Emmelin 1974 a) illustrates some of the activities common to an entire university such as interdisciplinary seminars and courses at the doctoral level. Since this classification is made with regards to educational strategy, the longer programmes could be included under this heading particularly since it is arguable that they produce specialists in planning (CESA); pollution control (Wageningen); conservation and natural resource management (Edinburgh) or engineers (Berlin). To avoid confusion these programmes have not been classified in this system.

1.4.4 *Complementing other education* (A:4)

Programmes in this category typically have an ambition to broaden the student's understanding of the environmental problems, using her previous background as part of the input into the courses. Contents may vary from the pluridisciplinary (UCL) to multidisciplinary (Trondheim, Salford, ESP 40). Stress may be on giving the student a broad knowledge over a rather wide field as an aid to relating her own speciality and communicating with other specialists (Trondheim, ESP 40) or on integrating her speciality into a particular field of environmental activities such as conservation (UCL) or a number of other areas such as water resource management, soil science, pollution and environmental control etc. which exist as post-graduate courses in the UK.

A number of courses teaching various special aspects of environmental problems — particularly relating to pollution — (Vienna) exist. A large proportion of such courses are clearly voca-

tional and a common arrangement is that university institutes give them in co-operation with professional associations, government agencies etc.

1.4.5 *Recurrent education*

Most programmes of recurrent and adult education deal with courses of the A:4 type. (Southampton EM). In relation to this study some points are of interest.

It is obvious that many of the A:4 courses and programmes now given as post-graduate education can profitably be included into recurrent education programmes. This is also done in many British programmes where some courses are run as Diploma courses. (UCL; Salford: option in countryside and recreational resource management, and in co-operation with the University of Manchester a course on biological conservation.)

The organisation of many such courses into "diploma programmes" means that academic status is lowered. To what extent this effects the employment value of the diploma is unknown. The reason usually given for lowering the academic standards is that this makes it possible to admit a wider range of students with little previous formal education. The experience of programmes which include such students in regular academic education seems to indicate that motivation, vocational experience and maturity make up for deficiencies in formal education. (Southampton EM; ESP). An increased participation by environmental programmes in recurrent education would seem to be urgently needed to increase general knowledge about environmental problems and prevent public interest and opinion to decrease or be distracted by other issues. The "energy crisis" underlines the need for offering continued environmental education to as many citizens as possible.

The organisational problems of participation in recurrent education must be solved for many programmes that now take part on the basis mainly of the enthusiasm of individual staff members. For a discussion of recurrent education on environmental problems see Bossenyi (1974). (Those interested mainly in educational development rather than "environment" should note that "it would be particularly expedient to use this new field of environment for trying out the recurrent education scheme which offers the best prospects for innovation in higher education with respect to its links with society" Duguet 1973.)

1.4.6 *Environmental health sciences* (B:ii)

Although Francis describes these as drawing on aspects of the bio-medical sciences, it is clear that due to the structure of medical education in most European countries the medical inputs are rather

smaller than is optimal in such programmes. As in other environmental areas there is a need for team work and participation of many specialists. Such programmes as Aston, Berlin, some of the pollution oriented specialisations in the post graduate level at Wageningen, Twente etc. are therefore useful inputs from various angles. However a closer co-operation between the medical, technical and environmental sciences to strengthen this aspect of environmental education is needed if fragmentation into specialised disciplines of aspects of pollution control is to be avoided.

In this respect Wageningen has the most advanced of the programmes in this study. It is obvious that this integration is due in significant measure to the fortunate but fortuitous institutional arrangement which has provided the necessary specialisations within the same educational institution.

It becomes even more important in the light of the growing interest in the quality of the work environment. Environmental education in Europe has yet given little attenion to the problems of the work environment being more oriented towards planning problems as a rule.

1.4.6.1 *Relation to work environmental problems*

It should be clearly recognised that there is a latent conflict between work environment and pollution control in respect of both economic priorities and methods. A co-ordination of education is among the many measures that will have to be taken in the near future if this conflict is not to become a serious hindrance to the efforts for both a better physical environment and safer work places.

Since most of the education relating to the work environment comes under national or regional agencies, professional associations, medical schools etc. the process of co-ordination and co-operation will be difficult. Present reviews of health education going on in many countries seem to have overlooked this aspect (an exception may be the Netherlands where representatives of e.g. the Wageningen programme are involved).

In educational systems with a great degree of local initiative universities may be able to contribute to the integration of environmental sciences, health and technology. In so doing they should not only look towards existing complete programmes (Aston) but to the possibility of integrating options into on-going environmental education. Such integration should be possible in for example Plymouth and King's College. It may take the form of parallel programmes utilising a common base and central options. Professional acceptance of graduates from such programmes is a central problem. It would seem likely to at least achieve recognition of the programmes for entry into specialised training.

1.4.7 *Environmental conservation and management* (B:iii)

Programmes in this category exist of variable length. Examples are Edinburgh (long, undergraduate), UCL (medium, post-graduate); Leiden (short) (cf. also 1.4.8).

Typically such programmes are pluridisciplinary — at least in core — and have grown out of recognition of the needs for new kinds of inputs into planning and management by ecologists, geographers, conservationists etc. Such programmes are often firmly based in a tradition of conservation and reflect the change that this concept has undergone in the last decades. This change is described as going from the economic ideal of safeguarding natural resources and protecting natural environments of scientific or amenity interest to the present position where the central concern is "maintaining all the environmental qualities — urban and rural — that satisfy man's aesthetic, economic and social needs" (Anon 1972).

Two things are notable in this definition. The first is that in several countries even the natural resource protection has only recently been incorporated into the aims of conservation as witness e.g. the problems of making inputs from ecology into the physical planning process (cf. 3.4).

The second point is the anthropocentric position taken. There is certainly no consensus among conservationists that mans's interest are central to conservation. The exception may be the Soviet Union where economic conservation — the concept of "complex use" — has been central (Pryde 1972).

The conservation programmes included here under "environmental education" all have the management approach which puts man's interests in the centre and makes the inputs compatible with other planning material.

1.4.8 *Combinations of categories*

As pointed out some programmes are either divided into specialisations or deliberately join some of the categories recognised by Francis (cf. 1.2.2).

1.4.8.1 *Planning and management* (B:i + B:ii)

Such programmes are even more clearly aimed at physical planning than B:iii programmes. They in fact seem to wish to provide alternatives to present planning education rather than complementing the inputs and specialising on certain types of management. The basis

for such programmes is a society where entry into the planning professions is not governed by very well defined educational requirements e.g. France. The best example is CESA.

In Britain the formal requirements for the planning professions mainly refer to post-graduate education and professional training. Undergraduate programmes such as Edinburgh, NUU, Plymouth are therefore in a theoretical position to make valuable contributions to the diversification of this group of professionals.

In other systems e.g. Sweden planners are mainly recruited among specialised architects and increasingly from a combination of geography and social sciences. When there is a recognised need for complementing it is usually in a technical speciality such as traffic engineering. Biological subjects are likely to make relatively little contribution to the education of planners since they are geared to the needs of the school system, producing mainly graduates with a combination of biological subjects and chemistry. Graduates indicate little interest in administrative jobs as a rule.

1.4.8.2 *Environmental health, planning and management* (B:ii + B:iii)

Programmes in this category are multidisciplinary. They have recognised both long-term needs for natural resource management and planning and the short-term need for immediate action against pollution which must be consistent with the long-term planning and management principles. Curriculum problems are perhaps most acute in this kind of programme since it is patently impossible to include all the subject matter relevant to the goals.

Two main solutions would seem to be possible to cope with curriculum problems. One is to make a long programme. Louvain offers an example. Even so the curriculum problems are formidable and the students may need some specialisation in order to find jobs. This specialisation is in theory available at Paris VII. In practice it turned out that only one could be offered — the regional planning option. It seems likely that large groups of students — particularly in central Europe — are likely to concentrate on planning options rather than pollution control, owing both to an assessment of the labour market and to a superficial analysis of the subject matter. Many students indicated that they considered pollution control "technocratic".

The other solution to the many practical problems of education in this category is to aim at the level of giving a broad knowledge of environmental problems to people with a previous specialisation — level A:4. This approach has been adopted (and clearly stated) by

Trondheim and ESP 40. The central option in the Environmental Resources programme at Salford and the Southampton EM might be considered to be in this category.

By a judicious combination of available programmes in the UK a student may build up a programme of studies in this category. It would be possible to arrange this in several ways starting either with a broad base from e.g. NUU, Plymouth or Edinburgh or from any relevant traditional combination of disciplines and broadening out in the middle of studies (Masters level, *second cycle*) at e.g Salford and then continuing to more specialised studies and research (cf. 1.6).

1.4.9 *Training for the educational system* (C:a)

The integration of environmental education into the school system is of vital importance to the forming of public opinion. It has not as a rule proceeded very far in spite of claims to the contrary. Interesting experiments have however been made and — perhaps most important — many school teachers of various disciplines have themselves done much to integrate environmental education into their teaching. It might be argued that this integration is working better in schools than at post-secondary level (A:1).

In some British schools environmental education exists as a new branch of teaching. Several teacher training colleges have set up programmes both for the education of new teachers and the retraining of old.

The flexibility of the school system is a key factor in this matter. In many countries the school system also governs the university structure in that a large proportion of students are going to become teachers in schools and therefore choose subjects at university which fit into the school curriculum. An increased attention in schools to environmental education would thus increase the basis for environmental education at university level. This is clear from the British examples where e.g. about half of the students of NUU go into the school system. A special joint programme between the School of Biology and Environmental Studies and the School of Education exists at NUU in order to give students a possibility to acquire competence as teachers.

1.4.10 *Education of decisionmakers* (C:b)

In the sense used by Newbould the overview courses have this aim. In the goal statement of the ESP 10 it is explicitly stated that the course should serve as a basis for public opinion making. It is

reflected in the mixed intake with a large proportion of people from outside the university. Similar aims are common in extra-mural courses.

The Pro Deo training course on environmental policy (Italy) is aimed more directly at decisionmakers. Universities as a rule seem to have played little role in the environmental education of politicians, business managers etc. A number of organisations have concentrated on such courses — usually in the form of short seminars etc. Many of these organisations are industrial organisations or federations.

Programmes in this sector fall outside this study, mainly for the regrettable reason that institutions of higher education seem to play a much smaller role than they ought. The traditional role of the university as a centre of critical examination of society is certainly not functioning in this respect (many historians doubt that it has done so since the Middle Ages).

For a discussion of the education of decisionmakers see Giacomini (1974).

1.5 The specialist-generalist controversy

In most discussions of environmental education the problem crops up of whether certain programmes educate specialists on the environment or generalists capable of understanding, dealing with or even solving environmental problems. The analogy from medicine is often used: the general practitioner who diagnoses the problem and knows what specialist to consult.

The entire problem seems to me to be a non-issue for several reasons. First of all it is based on a false analogy. Environmental systems are far more complex than the human organism, which however requires a decade or so of studies and practice, before the doctor is allowed to meddle with it. The validity of Francis' grouping of subjects shows that programmes are more modest than to try to educate environmental generalists — who would undoubtedly be quacks. Just as the trend in medical practice goes towards some measure of specialisation on top of a general training, so do the longer programmes in environmental education specialise.

There is an important semantic component of the controversy. The term generalist is in fact commonly used in programmes, but almost invariably in relation to the scientific disciplines that make up a programme, not in relation to the environment as a whole. Thus a graduate from UCL Conservation course is certainly a generalist in

relation to a botanist or zoologist. To a planner or politician she is however a specialist to be consulted on conservation.

In relation to labour market considerations there may be a real problem in that employers may not see the need for a person of broad training as a member of the team that will be needed to tackle all but the most trivial environmental problems. This may be a good reason for adopting the approach of the level 4 education where students already have a defined speciality on which they can rely when looking for jobs. In systems where a sufficient length of the total university education is available a combination of specialised and broad studies is possible. In this case a discussion of the suitable sequence of specialised and broad studies is much more fruitful than the specialist-generalist debate.

1.6 Sequence of specialisation and broad studies

A good case can be made for postponing specialisation until late in studies (graduate level or whatever is appropriate in the system). Broad introductory studies give the student necessary background and a variety of skills which can be used later. Typically these are mathematics and statistics as tools, and a wide range of subjects as knowledge. The early part of the studies can be used to give direction for the specialisation and also afford the basis for a change of direction in relation to specialisation that occurred at school. A broad basis makes the university system independent of the secondary school system which may help open the universities to new groups of students.

It is obviously easier to achieve some of the behavioural goals of environmental education if specialisation has not yet occurred to any great extent; notably those of broad outlook etc.

Most undergraduate programmes of a very general nature are either complemented with further studies of some specialisation (Wageningen, Paris VII, Berlin) or have been constructed in a situation where such studies are taken for granted. A range of specialised courses are e.g. indicated as suitable for further studies after graduation from Plymouth. Newbould (1973 b) concludes that generalised undergraduate courses could serve to educate teachers of environmental science for the school system but that for most other purposes they would have to be followed by specialised post-graduate courses (cf. 1.4.8.2).

In general in Britain fewer students continue to post-graduate studies than had been anticipated, for the university system as a whole, by the Robbins report. However, surveys of some environmental programmes made by CERI and the UCL Conservation course shows that a high proportion of environmental students do go on to specialis-

ed studies. This is part of the basis for the opposite model which claims that broad education should be done in schools and the first degree used for specialised studies which can form the basis for later broadening out and integration. Several programmes make use of the varying backgrounds of students (UCL, ESP 40, Trondheim).

This model fits better into the total educational systems of the northern European countries. It also fits better into systems which want to utilise recurrent education to a larger extent. The extremely good results reported in courses with students of varying background which includes vocational experience is an indication in favour of specialised undergraduate education (Southampton EM, Bossanyi 1974).

2.1 INSTITUTIONAL ORGANISATION

On the topic of organisation of programmes much could be said. It is however obvious that most of the analysis is interesting only in a national context. A comparative analysis of the constraints of national educational systems is outside the scope of this study. Some general conclusions, which may be useful in setting up or rearranging programmes, can however be made from my material.

Two conclusions are obvious to me: a programme must have [1] an independent organisation and [2] self-determination in budget matters.

A co-operation between existing departments may seem an economical and administratively attractive way of organising environmental education. It is also quite common to put programmes into an existing department – usually biology – or as a co-operative effort of two departments – often geography and biology. There are two dangers in this. If the programme is run on the terms of the contributing departments there is no guarantee that budgeting, curriculum construction, integration of other subjects will be done after an analysis of what the programme needs. The temptation to divide the thing up between departments, giving all a fair share, is quite obvious. This is particularly clear in situations where student numbers in other courses given by the departments is dropping off. An environmental programme may indicate a genuine interest in the environment, but it may also be an indication of the strong will to survive inherent in any organisation.

This is not to say that such an institutional arrangement is an indication of this state of affairs. There are many examples of strangely placed programmes with a strong and genuine desire to do a good job and with extremely dedicated staff. (Incidentally: all the examples in the appendix are included as positive illustrations.)

The second danger is that departments not directly involved in the organisation of a programme may equate it with the subject of the department – geography, biology etc – and lose interest or criticise it on the basis of no more detailed knowledge than its organisational home.

In pluridisciplinary programmes where the component subjects are fairly easily recognised and available within a small number of departments these dangers may be relatively unimportant, at least if the environmental education is quantitatively a major undertaking for all departments involved.

Three organisational models seem to me to be consistent with the above – and other criteria. The national and local institutional framework will decide which can be used.

2.1.1 *School of Environmental Sciences*

In major reorganisations or the founding of new universities a structure which cuts through the system up to the top may be

feasible. The names of such vertical organisations may vary – school, faculty etc. The important aspects here are that it is answerable directly to the governing body of the entire university and has its own budget which is allocated directly to it; that it contains several departments or institutes with the major component disciplines i.e. it is multidisciplinary or at least pluridisciplinary. It must have the power to hire staff and to draw on departments in other parts of the organisation and also outside the university. Finally it combines teaching with research of its own and thus is responsible for students at all the existing academic stages.

There are few examples of this type in Europe. Those that exist are pluridisciplinary rather than multidisciplinary. This is probably both necessary and good, particularly with regards to the initiation of research. If interdisciplinarity grows best out of research then a pluridisciplinary school with research groups on central topics which can be carried into the teaching programme seems ideal.

The organisation of the School of Environmental Sciences at the Plymouth Polytechnic clearly indicates that many of the problems of a combined research and teaching organisation which aims at interdisciplinarity have been considered. Within a school system it is organisationally simple to create the necessary ad hoc groups to treat problems arising in teaching and research. The system can be large enough to incorporate several members trained in various aspect of a scientific discipline, which helps to solve the problems of lack of contact with the "mother discipline" (cf. 2.6) encountered in a small multidisciplinary organisation.

2.1.2 *Departmental organisation*

In this model the structure is along the lines of a normal university department. This may be simpler to introduce into existing systems by conversion of a department. An example of this process is the Department of Forestry and Natural Resources at Edinburgh.

Such a construction will be extremely difficult to achieve if the university contains several departments with a strong interest in environmental problems. Pulling the components together out of other departments is seldom feasible and duplicating the equipment, staff, research and teaching may be too wasteful of resources.

2.1.3 *Programme co-ordination*

The simplest organisation to set up may be a joint programme with mainly teaching responsibilities. This may be a perfectly workable model if the independence of the programme is guaranteed by

a representation at the highest level of university decision making. An independent budget which is large enough for the programme to specifiy what it wants from departments and buy teaching, use of laboratories, equipment etc. wherever it suits the programme best is a necessary component of this model. The stress on specifying and buying instruction is strong. Compiling a course unit system made up of courses from existing departments taught to their own students falls very far short of the requirements for interdisciplinarity or at least co-ordination of environmental education. The "smörgåsbord" may be a satisfying culinary device but as a model for education it has severe limitations.

A model of programme co-ordination exists at the University and Institute of Technology in Lund (ESP) for several courses and a number of other activities except research. The Amsterdam IWG is an example of a similar programme with a small core staff which does not carry the main teaching load but co-ordinates a course. A problem of such programmes is often that its students are physically somewhat more homeless than those of ordinary departments.

In many British universitites a similar organisation exists and works very well in many forms of extramural education e.g. the Southampton Department of Extra-Mural Studies.

2.2 Origin of programmes

The institutional origin of a programme is obviously one of the most important deciding factors for grouping of contents, aims of a programme, institutional organisation etc.

It seems quite clear that in the majority of cases programmes originate in institutions of higher education as a response to some perceived need for education in the environmental area rather than as a response to an existing labour market (cf. 2.4). A whole set of motives relating to the crisis in higher education in the Western countries in the late sixties can also be recognised. In some institutions falling numbers of students and dissatisfaction with existing traditional courses have caused reorganisation of education in the direction of environmental studies. Some programmes have used this situation to reorganise along lines felt to be more satisfying to students and staff. This is perhaps clearest in new universities or departments. The inherent will to survive which exists in all organisations is obviously an important factor and may result in badly conceived and organised programmes which draw off a certain proportion of students from better programmes and discredit environmental education in general.

In a system where student mobility is great, academic freedom considerable and certain institutions traditionally have a greater prestige than others (e.g. in the UK) the bandwagon effect may be quite harmful. In such systems a "free market" in education is supposed to operate but may in fact not do so due to tradition etc. Good information to students (cf. 4.6) can perhaps help in maintaining the supposed free market. The experiences of consumer behaviour in other markets makes this assumption seem a bit doubtful. The need for some external co-ordination is pointed out (cf. the role of the CNAA 2.3). The centralised systems would seem to be in a good position with regard to this quality control. In practice however the central agencies seem only rarely to exercise it, possibly due to a lack of competence in respect of the contents of education.

The influence of the origin of a programme on the course content is interesting but difficult to analyse. The factors which have decided what is and is not included are often rather unclear to the organisers themselves. Reference is often made to availability of staff, institutions willing to co-operate etc. It is however also striking that an answer which states in essence that the programme contains "the essential background" or those subjects which "are most relevant to an understanding of environmental problems" without further elaboration is quite common. Programmes which bring in help from many institutes within and outside the university structure have often attempted a more thorough analysis of the essential content. As Francis (1974 a) points out this choice will mainly reflect the composition of whatever group makes the selection (cf. 3.1). This approach may well result in fragmentation rather than good coverage.

Many programmes have aimed at providing education in one of the four categories recognised by Francis (1974 b) cf. 1.2.2. Particularly in conservation and management existing departments have recognised areas where their expertise is relevant to problems and then tried to complement the programmes with other subjects identified by the organisers as relevant. The UCL Conservation course is a good example of such a process where the perceived needs for education of people going into one particular agency – The Nature Conservancy – was taken as the point of departure for the analysis.

Co-operation with the agencies or professional groups which a programme purports to educate students for seems rare. This is perhaps natural since the analysis is often of the deficiencies in education of the people now in office or the members of such groups. When consultations have occurred they have for this reason often yielded little useful information to those planning a programme. Education as seen by agencies or organisations is often not of the fundamental kind – background knowledge, attitudes to problems etc. – which the larger programmes seek to give. Specialised skills, detailed knowledge of the mode of operation of a particular agency etc. are

more often stressed. This information is more valuable in planning recurrent education, short courses and specialised diploma programmes (level A:4 cf. 1.4.4) than in undergraduate education.

2.3 Relation to national educational system

Among the many factors that decide the form and content of environmental education is also the structure of the educational system which forms the framework within which the programme operates.

The total length of university education is normally nationally determined. It is obvious that such thorough programmes such as Wageningen or the possibilities for construction of individual programmes in the UK can only exist in countries with a post-secondary education which contains all three levels – under-graduate, post-graduate and doctoral. The ideas of the Robbins report, of a rather generalised under-graduate education (as for example is given in NUU, Plymouth etc.) and a more specialised post-graduate training, have apparently stimulated the creation of some environmental programmes at both these levels. Newbould (1973) points out that the situation in the UK with regards to generalised under-graduate education may not be as favourable as this since a much smaller percentage of students apparently go on to post-graduate studies. This makes the position of the very general undergraduate programmes somewhat more difficult in relation to labour market problems.

A further advantage of the longer systems is that they are relatively more independent of the degree of specialisation offered in secondary education. A range of specialised and general undergraduate programmes will provide educational opportunity both for those who know their field of interest at school-leaving age and for the seemingly large group which does not. The several levels available in post-secondary education also means that a wide range of courses and programmes exist which can be fitted into recurrent education. Some universities in the UK have taken advantage of this (cf. 1.6).

The degree of centralised control in the national systems also influences the overall picture of environmental education. In content this seems to influence the programmes in the direction of vocational orientation in centralised systems such as France and the Scandinavian countries. In environmental education this is obviously a rather dubious concept since training is often not for a job but for a range of skills, basic knowdelge and attitudes which can be used in a great many jobs.

In the systems where a great degree of self-determination exists at the local university level experimentation with new programmes is

at its greatest. It is quite clear from this study that programmes have grown out of some recognised need for environmental education at the university level. The influence of national authorities has been minimal in almost all cases. In the early phases of development this is probably due to some process similar to that which has caused most important environmental problems to be noticed by scientists, citizen groups etc. At later stages it would seem that national environmental agencies, if they have shown any interest in education at all, have usually concentrated on shorter courses etc. relating to immediate needs. The communication between national environmental agencies and national educational agencies seems to be poorly developed. A further complication may be that higher education and research in agriculture, forestry, fisheries and such disciplines relating to natural resource use often come under other ministries, and the environmental health aspect under yet other. A lack of co-operation leading both to deficiencies in programmes and duplication of effort can easily result.

A distinct advantage of centralised systems is the chance for co-ordination and quality control which they afford. It is quite clear to me that some of the existing programmes in environmental education have not made a particularly wholehearted effort to plan the components of the programme. Existing departments have seen a chance to survive in a situation where ordinary students were not forthcoming in sufficient numbers. Little thought has been given to what disciplines ought to be incorporated etc.

A system which combines the advantages of local initiative with co-ordination and quality control exists in the UK. The Council for National Academic Awards (CNAA) approves the programmes from Colleges of Education and Polytechnics which wish to grant degrees. The rigorous planning, which has to be done in order to satisfy the CNNA – in fact it needs to be done simply in order to fill in the proposal forms correctly – is obviously good for the programme. The fact that the CNNA appoints committees with a competence to judge proposals in detail is naturally a further advantage. This makes real co-ordination of form and content possible, since a central agency with a good overall knowledge of the area exists.

2.4 Labour market considerations

Labour market considerations have usually not been primary in the establishing of programmes. As pointed out (2.2) the perceived needs of society for education have in many cases been more important. Higher education being a long-range process, which cannot accommodate short-term fluctuations in the labour market, makes this way of organising teaching seem valid to most people in close contact with university systems.

The very general programmes would seem to be those now having labour market problems. As pointed out many of the undergraduate general programmes were set up in the UK in a situation where they were seen in conjunction with more specialised postgraduate studies (cf. 1.6). In countries with a tradition of wide entry into professions combined with apprenticeship and professional, recurrent education these very general programmes may be quite useful in helping to provide a variety of backgrounds in such jobs as planning and management.

The tendency to believe in the existence of "a right kind of training" for any job is however quite strong, particularly among administrators. Fitting students into existing, well-defined jobs is the preoccupation of such administrators. No environmental programme in this study takes such an unrealistic attitude to higher education. In fact most programmes would seem to originate in the opposite attitude to higher education. It is interesting to note a lack of concern for the possible labour market in students in several of the more general programmes such as CESA, Paris VII, NUU, Salford. This may reflect an optimism based on the rather free entry into the planning professions which exist in France and the UK. In the UK it is also clear that a large proportion of the graduates from environmental programmes go into teaching with only little additional training (cf. 1.4.9).

Programmes which have adopted the approach described in 1.2.1 under A:4 i.e. giving environmental education to people with a specialised undergraduate education have solved their relation to the labour market problems in a somewhat different way. Their graduates already have a recognisable speciality in relation to existing jobs and are mainly aiming at environmental relevance in relation to previous training. Since this in fact exists in many jobs it need not be recognised in the description of a job. An example of such a programme is the ESP 40 where the 1971 programmes graduates have been asked for information about their jobs in 1973. Among the conclusions of this study are: a third of the students had jobs before taking up environmental studies and had returned to these jobs. Of the 27 graduates who by 1973 had a permanent position (out of 31 replies to the questionnaire = 94 %) 17 were in positions recognised as "environmental" by their employer. At the NUU – a general undergraduate programme – the 50 1971 graduates went into teaching (20), higher studies (17), industry (4), town planning (4), unrelated jobs (5). Of the 17 graduates from CESA in 1973 12 returned a questionnaire giving the figures planning (5), public health administration (1), higher study and research (2), unemployed or in military service (4).

A study of employment openings including a number of US educational institutions conducted by the CERI (1974) concludes that 2-12 months after graduation 60-70 % of the students have jobs. Experience

in European programmes not included in this study indicate the same. There seems to be a tendency towards a higher proportion finding (or going back to) relevant jobs from programmes of the A:4 type. However graduates from general undergraduate programmes cannot be correctly assessed since such a large proportion go on to higher studies. Only when they have left these is there any indication of the reaction of the labour market to such education.

Finally it should be noted that most programmes have been in operation for such a short time that no really valid results on the reactions of the labour market are available. Many programmes should not be evaluated against such simple statistical data but rather on whether their graduates can adapt to a changing situation, utilize recurrent education, professional training etc. better than graduates from other types of education. Such evaluation of higher education seems never to occur.

2.5 Staff

The problems of staff selection, competence, numbers, background etc. are intimately linked with institutional organisation and the origin of a programme.

With respect to the number of teachers involved there are two major and contradictory trends. Pedagogical considerations and institutional restrictions in hiring staff work towards small numbers carrying a large teaching load. The width of environmental sciences and the specialisation of the component disciplines on the other hand make for large numbers teaching small segments.

In general the pluridisciplinary programmes and the undergraduate ones involve fewer teachers. This is a function both of the fact that fewer and more closely related disciplines are involved and of the pedagogical aims. A smaller number of teachers is usually better from the student point of view. This makes for continuity and coherence in the teaching. As Clayton (1974) points out interdisciplinarity and integration of subjects is not a simple function of the number of teachers involved. It is often possible for one person to discuss a problem from several angles. The use of highly competent teachers in combination with student activity in seminars, essay writing, project work etc. is often a better way of achieving integration in undergraduate teaching.

In post-graduate programmes of the type aimed at providing broad understanding (A:4) there is a very acute problem in deciding on what teachers to involve and achieving a balance between continuity and coherence on the one hand and expertise and first hand

knowledge on the other. Programmes such as Salford, ESP 40, Trondheim, CESA involve a large amount of specialists and a varying amount come from outside the university systems. The need for such outside experts is generally but not universally recognised. Teachers are usually recruited from agencies, research laboratories and voluntary conservation organisations. There seems to be a rather general reluctance to involve industry-based scientists and administrators except for occasional lectures and visits to plants. There may be a danger in this practice, which probably stems from a feeling that to involve such people in the programmes would be to give "the opposition" undue chances of indoctrination. The danger is of course that students are not confronted with the wide variety of viewpoints that exist on all but the most trivial environmental problems. Practical work can (cf. 4.8.6) profitably be used for this confrontation which students need in order to function effectively in most jobs (cf. "dangers of integration" 5.5).

Recruitment and selection procedures to academic institutions varies greatly between countries. A less formalistic system where selection of staff is possible using interest in a programme, willingness to co-operate with staff members of different background etc. is obviously an advantage. In the more formalistic systems such as the French or the North European ones the programme structure of organisation (cf. 2.1.3) may be a useful way around this problem. Choice of teachers can be done both within and outside the university to suit the programme if an independent organisation with its own budget and only a small staff is responsible for the programme. That putting a programme within an existing department need not necessarily mean that choice of staff is restricted is shown by e.g. the Salford programme where some 70 visiting lecturers are involved in the environmental resources central option. The danger that existing staff rather than the best available expert on a subject is used is however real and evident.

A number of problems in relation to the staff of a programme are dealt with elsewhere: integration of outsiders (5.2); monodisciplinary education of staff in relation to interdisciplinary aims of a programme (2.6); research attachment (2.6); the student: staff ratio as a factor deciding educational methods (4.1); staff competence in relation to educational methods (4.8.1).

2.6 Research base

Research is stressed by many who write on environmental education, as a necessary base for environmental education. Positions vary with respect to the exact function of research. It is stressed as a more natural road to interdisciplinarity than teaching – indeed even the

only possible one (Clayton 1974). This is the basis for insisting on research in an institute giving environmental education or at least a staff which contains a large proportion of scientists involved in research programmes.

In the systems where a large organisation is responsible for a programme it is usually possible to set up research teams within this (cf. "school of environmental sciences" 2.1.1). Some programmes insist on research but do not consider it necessary to have their own teaching teams acting as research groups also, placing more emphasis on having teachers with a research background or involvement.

It seems that the insistence on research in fact is based on a multitude of reasons. One of these stems from an assumption that a scientist involved in an on-going research programme is better acquainted with the development of his field. The importance of continuously developing one's knowledge needs not be doubted. What seems much less clear to me is the basis for the assumption that involvement in research makes scientists particularly well read in a wide enough field. The necessary specialisation of the research scientist may be so time-consuming that the broad reading needed of a teacher in a general environmental programme becomes impossible.

Those staff members which teach a large segment of general background knowledge or attempt to aid the students in integrating knowledge from many disciplines need a very broad base. The problem of how to achieve this and what reward system can be devised to this end has been given little attention.

At present multidisciplinary research teams may be the best method of stimulating breadth in the knowledge of staff. Since academic reward systems are mainly oriented towards research achievement this may be the simplest way socially (and as pointed out perhaps also the most natural). However since a scientist is mainly judged by his "disciplined" colleagues this method has its problems. In scientific training a partial solution adopted in the US mainly is to have a group of senior academic staff responsible for a doctoral student. This can be composed of representatives of several disciplines.

A control of the academic reward system may make it possible for individual programmes to value teaching ability, broad knowledge etc. in members of the teaching staff. At NUU the policy has been to try to have staff members who can develop either a research or a teaching interest according to their own desire and to achieve a diversity of approaches in this way.

A problem of motivation may be inherent in the division into research and teaching. In research the need to follow developments in a speciality are obvious and the major constraint is simply time. The

motivation for wide reading in teaching staff may be more difficult to keep up. In recurrent education the varied background of students and the competence that they bring into the programme is probably a good inducement to modernise programmes and for staff to keep up with developments.

In other programmes it may be useful to invite outside expert to review the programme from time to time, to suggest areas for modernisation. The system of external examiners is perhaps such a measure. The proposal for increased international exchange of information on the basis of sending experts on environmental education and on special environmental problems around to programmes may also help in this respect (6.3).

In concluding, I would therefore like to say that although the need for a sound research base seems to be indisputable there are many problems, both organisational and other, which have not been solved or particularly thoroughly discussed in finding suitable forms for this integration.

A number of issues relevant to the research base are discussed in other sections: integration of students into research projects (4. 1.5), institutional organisation (2.1.1).

2.7 External contacts

As a rule community involvement is much smaller in European universities than in North America. In many European countries universities have a long tradition as national institutions recruiting students on a regional or national basis and with few natural ties to the particular community they are located in.

Environmental education has a need of external contacts in a way that traditional disciplines may not. Expertise from a wide variety of fields need be integrated into the teaching. The practical work which should be natural part of this education, whether in the form of seminars, projects or work periods, requires a good contact structure with the larger society outside the university.

The forms of external contacts are many – both formal and informal. An extremely important thought not formalised component is the involvement of staff members in environmental work on all levels – as consultants to national or local government agencies, organisations and industries. This brings first-hand experience of such work, of the working of agencies and industries, personal contacts which help involving outside experts in a programme etc. The degree to

which such work is compatible with the role of a university as a centre of independent criticism is debatable but not a problem peculiar to environmental education.

Involvement mainly in the form of critical examination is stressed in such programmes as CESA (cf. the existence of the Cahiers du CESA 4.8). The Leiden examination of a motorway construction programme has been mentioned also (4.7.6) and in fact almost all programmes can show examples of such work. It is obvious that independence of the universities must be combined with such good contacts, which permit the critical examination of environmental affairs to be based on sound factual material. There would seem to be a danger that critical examination is based on insufficient material and thereby has little impact but discredits a programme.

The most formalised external contact structure in environmental education seems to exist in the field of recurrent education in the UK. A number of programmes exist, some of which are included in this study.

It would seem that this field in general is rather poorly developed – mainly as a result of tradition. A great deal could be done to integrate the universities closer into society without jeopardising their independence. For examples from the US and Canada see Pratt (1974).

Co-operation with organisations and government agencies would seem to be possible in the educational field. Indeed it would seem to be easier to guarantee the integrity of the university in specialised courses, recurrent education etc. than in contract research, which is otherwise usually regarded as the normal field of close co-operation.

3. COURSE CONTENT

In this section I will attempt a discussion of contents of programmes. This is obviously fraught with dangers. My material is in nine languages there is great variation in how specific the course descriptions are as regards the details of content, the same terms are used to cover a wide variety of material – the worst being "ecology" and "geography".

3.1 Contents in relation to goals of a programme

In a discussion of the development of the Department of Man-Environment Studies at the University of Waterloo, Canada Francis (1974 a) states that "a plausible case can be made for including almost any subject under "environmental studies" so that a content approach to defining a curriculum would really become little more than an exhibition of the disciplinary biases and limitations of whatever academic committee set to work on it" (cf. 1.3, 2.2).

This attitude is typical of some of the new experimental universities and environmental programmes particularly in North America. The stated goals of these programmes are largely behavioural and stress synthesising ability, communication between experts as requisites for solving the environmental problems. The "process-over content" approach of Francis then becomes a logical way of constructing curricula.

In Europe most programmes state similar behavioural goals but also stress various disciplines as necessary background. The choice of these clearly does reflect the institutional origin of programmes (cf. 2.2). Many grew out of existing departments such as biology, geography, forestry etc.; research groups or informal groups interested in environmental problems. Usually interest was in producing an education in one of the categories recognised by Francis (1974 b) or of some level in the educational system (cf. 1.2.1). In relation to content the four categories of Francis are most relevant since once the choice has been made of one of these the grouping of contents is somewhat easier. The biases of organisers and institutional origin of most of the programmes are still clearly recognisable not only in choice of category but in what is regarded as necessary background disciplines and in the treatment of social sciences (cf. 3.5.1), technology (cf. 3.5.6) philosophical topics (cf. 3.5.4) and of course the choice of core courses.

Typically the longer programmes examined in this study have a pluridisciplinary core or basis and a varying number of multidisciplinary courses from which students have at least some freedom to

choose. Two arrangements occur: either a pluri- or multidisciplinary basis of about 1-3 semesters of study from which the program branches out into specialisation or a pluridisciplinary core with options from within the department or other courses existing in a University.

In the medium length programmes (approximately equivalent to one year of full-time studies) there is normally less freedom to include options. The programme is more of a designed unit. Alternative courses to give students of greatly varying backgrounds a certain amount of common knowledge may exist (ESP 40). On the other hand some programmes encourage students to specialise in their original field of studies e.g. the three lines in the Trondheim course.

Such programmes are often multidisciplinary but made up of pluridisciplinary units. Integration can be expected more within units than between them.

These programmes probably face the greatest problems when deciding on content. This is less acute in those which have decided upon a pluridisciplinary approach to one of the content categories. It is a major problem in those which attempt to increase communication between groups of specialists – level A:4 courses such as ESP 40, Trondheim, Salford. The existence of specialisations within the two latter may partly be in answer to this problem.

3.2 Overview courses

The overview courses are usually multidisciplinary in nature. Although usually claimed to be interdisciplinary one must doubt that a great deal of integration is actually possible. One particular problem of those which originate in the natural sciences is that they often attempt to be remedial in relation to a perceived lack of background knowledge. These basic facts are given so much room that analysis of problems suffers.

This is probably true of the Swedish 10 point programmes (of which ESP 10 is one variant). Different universities have tackled this differently, the most common solution being to make the core of the programme pluridisciplinary based on either biological or geographical subjects. In the ESP 10 an effort is made to transfer the remedial basic education to literature and use seminars, group work and lectures for the environmental problems proper (cf. 4.1, 4.2). A similar reason seems to have caused the reorganisation of the Utrecht programme (cf. 4.5) and be the rationale for making the Leiden course consist of a series of lectures on aspects of a specific planning or management problem (two examples are given in the appendix).

The approach "since you cannot cover everything anyway you may as well cover one problem thoroughly" may in fact be a better base for interdisciplinarity and integration in overview courses than the multidisciplinary attempt at broad coverage. This is often part of the aims of project work in short courses.

At the Institutes of Technology, which have tried very short overview courses, the problems of content has in some cases led to attempts to create similar courses, but designed for a section of the institute rather than for all its students.

3.3 Unifying concepts or themes

The need for a synthesis of knowledge from many disciplines is usually stressed as a primary goal of all forms of environmental education. This is perhaps the most challenging didactic problem but also the most difficult one. It is usually attempted in both curriculum design and in the use of various forms of teaching, if these aspects can indeed be separated. In many programmes more interdisciplinarity may in fact be achieved through the choice of teaching method than in the design of content of courses (cf. remarks on field work as a method for integration 4.8.6).

Referring to attempts at defining the contents of environmental studies Newbould (1973) states: "This can become excessively diffuse and some strongly unifying theme or themes are required. Three themes – not necessarily mutually exclusive – are discussed here: energy because every interaction of organism and environment is an energy transfer, and every important environmental system an energy system; systems analysis (Van Dyne 1970) because the general principles used to describe systems by logically defining their elements, states and relationships provide in themselves a strong enough discipline to unify environmental studies; finally the man-environment relationship, starting with human biology, physiology and behaviour and extending out to the physical, biological and social environment."

This obviously is the approach of an ecologist and as such typical of a major proportion of the programmes. In particular the use of energy and the definition of the approach to the man-environment relationship are indicative, going from basic natural science to more complex levels of integration.

Francis (1974 b) concludes that "there seems to be an active search to establish the bases for developing interdisciplinarity ... and approaches to this include steps to adapt and apply existing theories (systems theory), subjects (ecology), concepts (energy) or techniques

(computer simulations)." To these might be added physical processes in the geosphere in programmes based on the earth sciences (East Anglia) and spatial relationships of human activities for those based on geography. The concept "role" which unites several social and behavioural sciences (Weidner 1974) is not found in the programmes studied, none being in the category "community and human environments" which seems to be badly represented in Europe.

Among techniques might also be mentioned pedagogical methods such as field work (4.8.6), group projects (4.7.4) and the use of "real problems".

3.3.1 *Energy*

Paris VII indicates energy as a major unifying concept. Two of the "sensitising" courses at the beginning of the programme are "Thermodynamics and energy transfer" and "Application of thermodynamics to the Environment".

Courses on ecological energetics occur in several programmes. How well energy is used as a unifying concept is difficult to judge but it would seem likely that few courses carry it to the point done by H. T. Odum 1971). Most would seem to stop at models of energy flow through natural ecosystems or if man is included-non-urban ecosystems (cf. remarks by Newbould on problems of urban ecosystems 3.4).

Energy is of course dealt with in a technological sense in several programmes: in conservation or pollution aspects of energy conversion.

Courses examining economics or social environmental problems examine the growth processes which lead to increased "energy consumption".

3.3.2 *Systems theory and simulation*

This term is often loosely used to describe any logical ordering of material. On the other hand course names such as ecological modelling, mathematics, simulation etc. sometimes cover systems theory.

The Twente University of Technology gives "systems analysis and model building techniques" as one of the three basic disciplines in its Environmental Engineering programme. Paris VII has modelling of ecosystems as part of a course on methods of mathematical analysis.

One reason for the fact that systems theory and simulation are as yet comparatively rare in programmes may be the lack of teaching staff in combination with insufficient access to computers. No pro-

gramme however complained that the latter was a problem. If it operates as a constraint it probably works on the research and if such techniques and theories are not used in research they are not likely to be used in teaching.

Systems theory and simulation should be important means of getting certain important groups within the environmental sciences to communicate. Getting spatial and functional models to work and to provide inputs into planning should get ecologists and geographers to co-operate. Modelling aquatic ecosystems is a field of co-operation between ecologists and engineers which seems to work rather better than communication on water pollution control. Economists and ecologists might make use of systems theory for common projects. These developments are likely to occur in research rather than teaching but should be used in environmental education whenever possible.

A danger of the superficial use of systems theory in education is that it may give students the impression that it is an "objective" tool for decisionmaking which does away with value judgements and political processes. There are obviously those who teach something like this.

The use of simulation should also teach students that modelling is exercise which reveals something about the assumptions and data that make up the model, not about the reality from which one is supposed to have drawn these. The use of modelling to indicate need for further study and what approximations can reasonably be made about complex interacting systems is very important. Uncritical use of the results of modelling exercises must be discouraged (4.7.3).

3.3.3 *Geography*

The use of spatial relationships as a unifying concept would seem to present certain problems and needs complementing with functional relationships derived either from ecology or sociology.

The co-operation between geography and ecology on problems of conservation, land use and planning seems to play an important part in some British courses e.g. NUU and UCL. Geology is also brought into this in some cases. This seems to be in line with the British tradition of human ecology represented by Fraser Darling (1951, 1955) and Dudley Stamp (1955).

It is often pointed out that the teaching of geography has much in common with environmental education – or in fact is environmental education. Drawing on many of the same disciplines and tech-

niques geography has learned many things about turning pluridisciplinary courses into interdisciplinary education. This experience should be utilised wherever available. It is not everywhere available since there has also been a tendency to try to make geography into a traditional scientific subject rather than an interdisciplinary meeting-ground of disciplines. An interesting discussion of the contribution of geography to the education of human ecologists, which is relevant for other environmental education also, is given in a paper by Bowen-Jones (1973). Going further into the use of geography as a unifying concept would seem to be beyond the scope of this study and certainly beyond my competence.

In the broad classification of Francis geography as a unifying subject is most commonly used in the "environmental design" programmes. It should be clearly recognised that there are programmes which attempt to unify the categories "environmental design" and "environmental conservation and management" (cf. 1.4.8) and that there is a conflict between the use of ecology and geography as unifying subjects. There is in this respect also a conflict in vocational aspirations since some of these programmes evidently attempt to produce graduates which can compete with geographers for positions in planning authorities.

The conflict between geography and ecology as unifying subjects – if identified as such – is solved either by deliberate choice of either (ecology: NUU, Edingburgh, Salford; physical geography: East Anglia), or by presenting both or letting the student specialise through choice of options (Plymouth). In several programmes neither subject seems to be used as an overall unifying concept even though either or both may be used as such in individual courses (Paris VII, Wageningen, ESP 40, Trondheim, Louvain). Here the approach is more to use ecology and geography as contributing subjects in the total structure of the programme. These programmes are as a rule multidisciplinary whereas those using unifying subjects tend to be pluridisciplinary.

3.4 Ecology

That ecology is a central subject in environmental studies seems accepted in most but not all programmes. Definitions of what ecology actually is however vary to such an extent that closer analysis is certainly needed to understand the role of ecology in environmental studies programmes. As pointed out already a content analysis presents many problems.

In some cases however it is possible to get a reasonably clear picture of what is covered by "ecology" in a course plan. Often additional descriptive terms pertaining to the particular emphasis given in

a course are helpful – terms may refer to a biome: tundra, alpine; or they may limit it to certain organisms: animal ecology, microbial ecology etc. In such cases a reasonable consensus usually exists on what is included. However the terms social ecology, human ecology and variations thereof present more of a problem. It is quite obvious that they can (and do) cover anything from sociology, economic geography to botany or zoology.

In most of the cases examined it seems reasonable to say that ecology is used as a framework within which certain human activities are studied in addition to the study of what may be called "natural ecology" (a slightly illogical but probably understandable term *) (cf. unifying concepts 3.3). The use of ecology as a conceptual framework can be based on a variety of features of ecology. Newbould (1973 a) lists some of these:

1. The ecosystem concept including the taxonomic, structural and functional organisation of the ecosystem.

2. The functional model of the ecosystem, involving energy flow and mineral cycling.

3. The concept of up to five sets of potentially independent factors controlling the ecosystem.

4. The dynamic nature of ecosystems; their tendency to develop from simple, uniform, productive, unstable systems to complex, stable, diverse, protective systems.

5. The continuity of ecosystems assured by the transmission of energy patterns, genetic information and, in the case of human ecosystems, cultural information through time.

However, certain programmes obviously use ecology in a more limited way – as one of many contributing branches of knowledge. This is obviously due to a consciously pluri- or multidisciplinary approach rather than an interdisciplinary one (cf. "dangers of integration" 5.5).

Clayton (1973) in describing the East Anglia programme goes further: "I am happy that others should use ecology as their road to the understanding of the environment. But I am clear that it is not the road I seek to follow at present. The ecologist is still studying small sub-systems in isolation, and neither he nor anyone else can relate the limited understanding he has achieved to the different scale problems of the world etc."

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* see 0.2.

Ignoring the overstatement which shows a certain lack of contact with modern ecology this quotation poses certain interesting problems that most programmes have not really faced. The first one is a methodological one and is discussed in 5.5. This and similar views of the usefulness of ecology are not uncommon and students are seldom exposed to them in courses.

The second problem is more serious and concerns the applicability of ecology to human systems of varying complexity. The assumption that ecology is a useful base for all kinds of programmes irrespective of level of teaching and aims of the programme needs closer study. The lack of discussion on this point is striking. I am neither questioning ecology as described above by Newbould as an intellectual framework nor the use of ecology as the foundation for conservation of wildlife, management of forests, fisheries etc. What I am concerned about is the exact role, at this stage of development of the science of ecology, in regional or national physical planning. It seems obvious that ecology cannot provide the exact and quantitative inputs that location of industries, development of urban areas, pollution control etc. demand. Newbould (1973 a) states the problem: "Ecological concepts can be helfpfully applied to simple situations, including islands, isolated communities, primitive tribes and subsistence agriculture communities. There remain problems in applying them to twentieth century urban man because the populations to be studied cannot be isolated and because inflows of energy and information tend to be very large compared to ecosystem energy flow deriving from solar radiation. However on a whole world or biosphere scale as outlined above ecological concepts are more easily applied since the limits of the system are definable and for most purposes it is a closed system."

Illustration of the problem is afforded in the attempts at incorporating ecological information into regional or national physical planning e.g. in Sweden. Ecology is often made into some kind of biogeography and the input into planning becomes merely information on the spatial distribution of organisms or ecosystems. The functional aspects such as stability, cycling of polluting substances, tolerance to loads of organic matter etc. are lost. The use of all kinds of planning exercises, making of management plans which include urban man etc., is likely to have a beneficial effect on many programmes, providing both realism regarding the possibilities of ecology and stimulus for research and development of this important aspect of the science (cf. 4.8.6).

In this respect those programmes which aim at teaching management skills and the pluridisciplinary ones based on biological and geographical subjects seem to be the most realistic. They have sufficient professional ecologists and staff with practical experience to ensure this.

The competence of ecologists is in this context an interesting problem of which there has been relatively little discussion. One

wonders whether the ecologists trained in "natural ecology" who are teaching some of the more ambitious environmental programmes consider their own students as ecologists. At CESA Professor Labeyrie's answer is negative – he will not accept students of CESA in his ecological research programme. The fact that such a large proportion of British students from environmental programmes go on to higher studies must indicate that many institutions find their knowledge acceptable. The Paris VII students have problems at present in this respect since their diploma is not recognised as entry qualification to higher studies.

However one must be careful in drawing conclusions. The French system is much more formalistic than the British and acceptance may be a poor indication of quality. Comparing a graduate from Wageningen and one from ordinary biology studies in Sweden I would contend that the Wageningen graduate has a better background for research in most traditional biological subjects including ecology.

On the problem of the ecological competence of teachers there is really no answer obtainable. Since the definition of the subject varies each programme will have different criteria of competence. In the programmes using ecology as a basis of scientific knowledge there seems to be two major groups which are likely to have different competence and content problems. These relate to the grouping of programmes into "environmental conservation and management" and "environmental health and pollution control" (Francis 1974 b) (cf. 1.2.2). The problem is one of both content and staff since the former is to some extent determined by the latter and staff number in relation to the necessity of covering a wide range of subjects is a problem in most European programmes (cf. 2.5).

In conservation and management programmes the problem would seem to be one of delimiting, vis-à-vis geography and to some extent planning and landscape architecture. Some programmes have consciously set out to provide an ecological training which is offered as an alternative to other types of education of planners. Here ecology is the central theme and other subjects brought in when the ecologist recognises a need for them.

In the health/pollution programmes the problem is often to achieve a balance between ecology, physiology and chemistry, and the balance varies greatly. The organising institute, the background of the teachers etc. determine this to a large extent.

In technically oriented programmes the role of ecology is as a rule small. When biological aspects are brought in they tend to be physiology, toxicology and medicine in programmes concerned with pollution control and chemical engineering. In civil engineering there seems to exist a serious lack of communication between limnologists and engineers. In many cases this results in second rate ecology teach-

ing for these students. Systems theory and simulation ought to be tools for communication since these theories and techniques are taught to engineers and used e.g. in hydrology, and ecosystem modelling in limnology is well under way in several scientific centres (cf. 3.3.2).

The role of ecology in many technical programmes is perhaps also determined by the engineers' concept of ecology (cf. 5.5) – many having a tendency to equate ecology with the preservation of plants and animals and finding this incompatible with the economic and social goals of their work.

The balance between ecology and other branches of biology is most problematic in smaller programmes and in particular the ones trying to combine management and pollution control. In programmes of several years' duration relying on large institutes (Wageningen) there are both time and resources available for a balance which may vary according to the interests of the student. In discussions in Edinburgh arguments were put forward to the effect that the ecological management approach is in fact fundamental to pollution control also. It does not seem to be quite as simple as that in programmes such as the ESP 40 where the aim is to provide e.g. an engineer with a good understanding of what the effects of pollution created by him are, or an administrator with knowledge of these effects as a basis for sound and differentiated legal action (A:4; 1.4.4). Without denying the need for ecological knowledge I would stress the complementary need for chemical, toxicological etc. information.

As has already been pointed out the uses of ecology in environmental education is likely to influence the development of the science also. Ecologists confronted with the problems of teaching these courses must have frequent cause for reassessing their work. The broadly educated students which go on to ecological research can hardly fail to have an impact.

In the overview courses (but also in larger programmes) there seems to be a certain risk of overselling ecology as a combination of unifying theme and source of knowledge. This may in part also be a competence problem. Many proponents of ecology are not trained ecologists and their claims must be rather horrifying to the professional ecologists. These tendencies are perhaps clearer in non-university education and in certain US programmes. From planners, architects etc. who have attended short lecture series on ecology I have repeatedly heard comments which have been variations on "Is this all? I had expected a neat system to hang our planning methods on."

Although a realistic presentation of the uses of ecology may be less satisfactory to the audience and the popularity of the lecturer it is absolutely necessary if we are not to produce a backlash. Such a

distrust of ecology would be a great disservice to those more thorough programmes which attempt to equip students to make good ecological inputs into planning and management.

The uncritical acceptance of the "limits to growth" and similar modelling exercises and the rejection of the serious methodological criticism that has characterised the teaching of many environmentalists is likely to contribute to this lessened credibility of ecology.

3.5 Contributions from certain disciplines

The roles of ecology and geography as unifying concepts for environmental education have been dealt with above. In this section I wish to discuss some aspects of other scientific disciplines or groups of disciplines that are conspicuous in environmental programmes — mainly those of medium and large size — either because they are given special treatment or through their virtual absence.

3.5.1 *Social sciences*

The position of social sciences in environmental programmes is interesting. Most recognize them as central to the understanding of environmental problems yet give little room for teaching of any of the social sciences. This is particularly striking if one makes a distinction between "analytical" and "utilitarian" aspects of the subjects.

The description of social science components of programmes usually stress practical aspects rather than analytical. A typical example is the indication of content of the part 3 in the UCL programme.

Another indication of the utilitarian aspect of social science is the type of persons used to teach these components. They are often drawn from administration rather than scientific departments. This is often because the aim is to explain the structure and function of existing administrative and legal frameworks for pollution control, planning, conservation etc. This is obviously a perfectly legitimate part of programmes. Students need to understand these things and a practical experience of work in the systems is indispensable. Those programmes which state a critical examination of the social and cultural framework as their aim should however ask whether they have not stopped at the level of necessary background without reaching that of sufficient analysis.

The reasons for this state of affairs are several. First of all several programmes have no ambition beyond giving some knowledge of the framework within which their skills will be applied (perhaps true

of: Wageningen, UCL, vocationally oriented programmes such as Aston).

It is also quite clear that the origin of programmes show in the attitudes to social sciences. The social science components bear the mark of having been specified by other than social scientists in response to perceived needs for corollary subjects rather than central analysis. There is a clear element of criticism of the social sciences implicit in this. Some of this – but certainly not all – criticism is based on lack of knowledge of the social sciences. (The situation is perhaps somewhat similar to Clayton's criticism of ecology as a unifying theme cf. 3.4.)

Abillon (1974) discussing the problems of integration between the natural and social sciences voices one common attitude of natural scientists: "At present this is difficult because principles of operation that relate to quantifiable and quantified parameters cannot easily be applied to unquantifiable parameters."

This view is perhaps most vigorously criticised by some economists, who see their subject as the basis for such integration. The use of systems theory might be another possible method of integration or, as Abillon indicates, energy. Whatever one's position is on these issues of integration one must deplore the lack of communication which is often based on such unscientific reasons as ignorance, arrogance on the state of development of a particular science or the claim that one's own science has all the answers already. The blame can probably be evenly distributed between all concerned. It seems clear to me that C. P. Snow's (1964) prediction that the social sciences would provide a meeting ground for "the two cultures" is unlikely to come true. In fact environmental science may achieve it if it comes to grips with the problems of integration of the social sciences as analytical tools. This is hardly likely to occur in the near future or as a result of teaching programmes (cf. comments on research 2.6).

The utilitarian trend in use of social sciences is dominant but not exclusively so. Examples, which indicate analytical ambitions, occur in the material. The Human Ecology option at Plymouth is split into "the biological context", "the social context", "the political context" and "agencies of environmental change". The descriptions of the components make it quite clear that they have an analytical aim. Staff members for this course come from the social sciences. In the one semester programme at Trondheim the analytical aims of social sciences are dual. In the common introductory part it occurs as a necessary background (the other two being biology and technology). In the specialisations the aim is to give students of social sciences a chance to deepen their analysis of environmental problem and to bring these analyses into the common part of the programme (project work, seminars etc.).

3.5.2 *Economics*

What has been said above on the utilitarian aspects of the contributions from social sciences is largely true of economics also.

Examples of a more analytical use of economics seems to be CESA and Louvain among the larger, and Amsterdam IWG among the overview courses.

Developing interdisciplinarity from research is the object of a multidisciplinary group at the Free University of Amsterdam in which economics plays an important role.

In the traditional teaching of economics environmental problems are given increasing importance (for an example of the integration into existing subjects – level 1, cf. 1.4.1).

In some of these the inputs made from the environmental sciences seem dangerously small. This leads to problems which may invalidate the results of economic analysis.

Examples are the equating of all sorts of pollutants whether they are heavy metals, synthetic chemicals or organic matter. Cost benefit analysis has been made without regard for the fact that for some pollutants there is accumulation in food chains, others have a varying turn-over time and yet others i.e. organic matter cannot be regarded as pollutants below a certain but variable level. As pointed out previously systems analysis may be a tool for making the inputs sufficiently sophisticated. This however can only occur if economists are educated on the needs for such sophistication and ecologists and toxicologists are willing to make their contributions in a compatible form. Discussions with the research group at The Free University of Amsterdam indicated that efforts are being made in this direction. It is to be hoped that results of this work will be incorporated into education not only at the Free University. In general I think it is realistic to say that such a process of spread to other teaching institutes is likely to be slow. (cf. 1.4.1)

3.5.3 *Law*

The contributions of this subject are perhaps even more clearly utilitarian than those of social sciences and economics. As pointed out previously there is of course nothing wrong in this.

Since administration in central and northern Europe is based traditionally on university education in law it is important that students of environmental courses in these countries get a good understanding of the legal systems and their structure and function, an understanding of the language used by legislators etc. We find that the exact and differentiated use of language which is characteristic of the legal professions is surprisingly little appreciated by scientists.

3.5.4 *Philosophy*

The importance of local academic tradition is apparent in the structure of environmental teaching in Oslo where both the existing overview course and the one semester programme beginning in the autumn term of 1974 show the influence of the Oslo school of philosophy. From this school an examination of environmental problems is made in the light of comparative philosophy. The historical and cultural changes in the way in which Man has regarded Nature and his place in Nature are analysed. It is interesting to note the ready acceptance of this "ecophilosophy" by many natural scientists and engineers when contrasted with their attitudes to social sciences.

The Oslo "ecosophy" should not be confused with the many, particularly North American, variations of Ecology as a road to salvation. The "ecosophy" originates in philosophical analysis and a humanistic tradition.

It would seem important to include some historical and philosophical aspects in environmental courses of all kinds. In particular natural science students need an analysis of value systems and a historical perspective. This has been appreciated in some programmes. The Amsterdam IWG has a section "values and norms", while several conservation programmes analyse the development of the concept of conservation (cf. 1.4.7) and touch upon Man's relations to Nature when discussing the objectives of conservation.

A plausible case can be made for including almost any subject under "environmental studies" ... (Francis 1974 a; cf. 3.1). I am not advocating that large sections of history or philosophy be included in every course but merely that attention be paid to the problems of value systems and a historical perspective. This can often profitably be done during treatment of some central theme such as the objectives of conservation, health programmes, pest eradication. I am also advocating that such discussions become much more rewarding if a little aid from philosophy, the arts or humanities or whatever is locally available is enlisted. It is all too easy to dismiss these aspects with some introductory remark on the Ancient Greeks, the fact that Plato laments the devastation of forests, or some such learned superficiality.

3.5.5 *Behavioural sciences*

The contribution of these is again rather limited and utilitarian. It is often confined to survey and polling techniques. In environmental design programmes the elements are usually more prominent, since these courses deal with the perception of landscapes. In "community

and human environment" programmes in the US the role of the behavioural sciences is usually important. As pointed out such programmes seem rare in Europe and are outside the scope of this study.

The environmental overview courses are in a strange position in relation to the behavioural sciences since they often purport to deal with "quality of life", increases of material consumption, life styles etc. without attempting to bring in the behavioural sciences to aid in the discussion and analysis. Some have drawn the logical conclusion of this paradox and leave the discussion to individual students and concentrate on what are perceived as necessary background facts for the discussion. As pointed out they see their role as remedial in relation to the school system. (3.2)

The fact that many programmes originate in a biological milieu means that those which feel the need for behavioural analysis often use ethology as their point of departure (Plymouth, NUU). This is likely to increase distrust of such programmes from social and behavioural scientists if not balanced by other approaches. If however ethology is given mainly as a biological subject and analogies with human systems are made cautiously the combination of social sciences, behavioural sciences and ethology may serve as excellent illustrations of the problems of interdisciplinarity.

3.5.6 *Technology*

The role of technology in non-engineering curricula is interesting. The term is not infrequent and is normally used to designate technical measures for pollution control, descriptions of the effects of various types of industries etc. As under social sciences the choice of matter under the heading technology is distinctly utilitarian rather than analytical. In most cases it is also obvious that what is covered is a fairly traditional description of the problems of the major industrial activities – particularly heavy industry and energy conversion.

Often the teaching is restricted to listing the effluent problems and the various kinds of equipment used to control these. A more total approach to the problem would be to look at energy flows and cycling of materials in industry. The best long-term approach to many pollution problems lies in changed industrial processes or raw materials, yet this is rarely taught. One major exception may be nuclear energy problems where several programmes state attempts to look at what is termed the nuclear fuel cycle i. e. the total problem created by nuclear energy conversion.

It is also interesting to note that the non-engineering programmes make little or no reference to technology as a concept or method to tackle problems. The aims of the Engineering Concepts Curriculum

Project have had no influence on environmental programmes in Europe. The following quote from the preface to the first version of the textbook "The Man-Made World" produced in this project would otherwise seem to be of interest to environmentalists:

"Man now has faith that he can shape his own environment and that he need not leave his destiny to chance. His knowledge, ingenuity, and vigour give him power to change the world toward what he wants it to be, rather than having to accept it as it is. This is the engineering viewpoint, for the engineer thinks of the world in terms of how it can be modified to serve man."

What I am here referring to is not a lack of discussion of the attitudes expressed. Most courses are full of condemnation of this attitude though rarely of analysis of its historical and philosophical roots (exceptions: Amsterdam IWG and Oslo cf. "philosophy").

What is rarely dealt with is the power of the engineering method – the art of defining a problem so that it becomes solvable. The lack of appreciation for this method is at the basis of the lack of communication between ecologists and engineers (cf. 3.4). Only when environmentalists are taught to understand the power of disregarding vast amounts of information in order to handle a problem are they likely to try to make their information compatible with other inputs into engineering.

That engineers are aware of the dangers of the method is apparent e.g. from The Man-Made World or the Danish report on environmental education prepared by the subcommittee on technology which states that: "The formulation of a problem in itself decides how it is solved. Training in the formulation and solution of problems, taking a number of technical and non-technical factors into consideration, is therefore an important part of education."

There are however great problems in the presentation of the engineering approach. Such problems include the lack of suitable texts. In the ESP 40 texts were produced but did not really convey a sense of the existence of an approach common to several branches of engineering. The course was therefore broken up and the components integrated into other courses (cf. 4.2).

3.5.7 *Mathematics*

The use of mathematics in programmes with a large amount of ecology is particularly obvious in the UK which perhaps is a result of the process orientation of much British and American ecology. In some programmes the term "mathematics" is used rather loosely and would seem to in fact be used for courses in rather elementary statistics.

On the problems of teaching students of ecology, environmental science, planning etc. the necessary mathematics there seems to be little systematic knowledge gathered.

There are obviously many interesting didactic problems here. On the one hand the need of these students is for reasonably sophisticated mathematical techniques; on the other hand neither time, background knowledge, available staff or inclination of students is normally particularly helpful in this respect. The applied approach taken in engineering education is probably the best source of experience for such education. It is clear that several programmes realise that "dirty mathematicians" is what they require. Staff members typically have engineering backgrounds, have worked with applications of mathematics in industry or research programmes. Others may be biologists, physicists etc. with formal education in mathematics and great experience of applications in their scientific field.

Recently a number of useful textbooks designed to meet the particular needs of basic training in mathematics or to introduce and motivate students to learn mathematics have appeared in English. The approach of these books and the background of authors seems to be roughly those indicated above. The need for mathematics is increasingly stressed in textbooks on ecology – e.g. "Students will find that they can understand ecology without knowing any mathematics, but that mathematics is necessary for those who wish to proceed beyond the simplest level of analysis. Ecology is not a haven for people who cannot do mathematics, . . ." (Krebs 1973). Indicative of the approach is the following quote (Maynard Smith 1971): "I shall be satisfied if I have said enough to show the reader what kind of thing is being said in these theorems, and to convince him that they are not wholly implausible. . . . Historically people used these ideas quite happily for a long time before adequate definitions or proofs had been given."

The course unit system may be a complicating factor in some educational systems in that courses adapted to special needs are few on the undergraduate level. The mathematics offered may be taught by mathematicians for mathematicians.

This is overcome in the larger programmes which can either give their own courses or buy specially designed courses from other departments.

Several programme members that I spoke with indicated that one problem is that although they realise the need for mathematical knowledge they themselves have little. In this situation it sometimes becomes difficult to motivate students and produce exercises which prove their point.

It is suggested that the development of texts, curricula, exercises etc. in this field can well be done on an international basis. The problems of co-production of material would be small since only translation rather than adaptations of written material would be needed. The proposal is outlined in 6.6.

3.6 Perceived deficiencies in content

Most programmes are critical of their own approach and actively trying to develop. In discussions with staff it was rather clear that the lack of social sciences and economics in many programmes was felt quite strongly. The various reasons given above for this state were given or made clear. There may also be local problems of lack of disciplines in an educational institution or a specialisation of the subjects that makes their representatives uninterested in environmental problems.

Given in descending order the stated needs for better contributions from other subjects to medium and long programmes were: economics, social sciences, law, behavioural sciences, humanities.

4. TEACHING METHODS

4.1 Lectures

The lecture is a central part of almost all environmental programmes in Europe in spite of recurring criticism of this form of teaching. There is a whole set of reasons for this. Some certainly may be inflexibility of institutions or attitudes of academic staff. There are however two groups of deciding factor which I consider much more important for this state of affairs.

The first group – which makes lectures the only feasible method of teaching in many cases – are logistic. A well-delivered lecture is the cheapest method of conveying information to a large group in terms of money or manpower. In fact it is doubtful whether it is not the most efficient even in terms of total time used by all involved if the alternative is to produce an illustrated text. In reality this alternative rarely exists because of limits on resources for typing, duplication, production of illustrations etc. The lack of suitable textbooks, which is not likely to be a transient phenomenon since approaches will (and ought to) vary and the entire field is in rapid development, makes the economics of the lecture in environmental education particularly great.

When it comes to the involvement of persons outside the university there is often the choice between a lecture or nothing at all.

Many programmes are not free to determine their own intake of students and lecturing becomes the only feasible method of teaching the core of required knowledge. The ESP 10 is in such a position. The production of textbooks in this programme is aimed at providing students with most of the basic factual material of the course in order to use lectures as an efficient complement (cf. 3.2).

The reasons so far stated are mainly negative in that they are due to various constraints which makes lecturing the only feasible method of teaching. However there are many excellent reasons for the use of lectures. Contrary to some opinions these are perhaps greater in environmental education than in more traditional subjects. I cannot see a conflict between the proper use of lectures and even highly individualised and conversational styles of education such as those of Roskilde, Green Bay etc. The proper use of lectures might be defined as in the Plymouth programme outline: "... lectures are large rather impersonal gatherings of thirty to a hundred students, which are generally used to give a synoptic view of a field of study. The detail is then filled in by more personalized teaching of four main types – practical work, seminars, tutorials and guided reading."

The synoptic view is of course most important in a heterogenous and rapidly developing field such as the environmental sciences.

It should be noted that much of the criticism of lecturing is in fact aimed at or caused by bad lecturing practices: too many lectures, badly prepared or delivered etc. The rapid growth of university enrolment in the Sixties, matched neither by resources nor by staff competence, lowered standards of lecturing in most systems. National traditions play an important role here. Undergraduate education has fairly low status in Central and Northern Europe. The academically highly qualified staff has therefore been little involved in this teaching. If it is accepted that high theoretical competence is a prerequisite for a synoptic view of a subject it is hardly surprising that lecturing has fallen into disrepute in those systems. In the English-speaking universities there has in general been a higher standard of lecturing, smaller groups etc. The less rigid specifications of required knowledge gives lecturers greater freedom to chose interesting topics, illustrate current scientific controversies etc. Strongly examination-oriented systems such as those in northern Europe are in a much less favourable position in this respect.

Examination of course outlines show clearly that a great deal of thought and effort is spent on these problems by many programmes. The north and central European ones are in obvious conflict with their national traditions regarding the competence (academic or other) of lecturers for undergraduate or short courses. It is obvious that they are less bound by considerations of academic status in looking for expertise although they also seem to use senior academic staff more when it comes to teaching of traditional disciplines. The tendency to recruit on a regional or national scale, even for the occasional lecture in short courses, is clear.

The combination of lectures and seminars adopted by some of the Dutch overview courses is described in (4.8.1). This seems to be a particularly useful approach if group size is too large to permit good discussion directly in the lecture.

4.2 Literature

The use of literature in courses varies between national systems. In some there is great emphasis on covering as much of the course contents as possible with prescribed textbooks (Scandinavian countries). In others the system of recommended readings dominates (UK). Each have specific problems. In several overview courses (e.g. the Dutch) there is little or no use of textbooks.

The use of prescribed texts which is central to higher education in the Scandinavian countries presents special problems in environmental education. The lack of suitable textbooks is marked, particularly for interdisciplinary courses. Since the approach varies

greatly between programmes and is determined by many factors, some of which are obviously organisational or personal to the staff involved at any one time, it is highly unlikely that useful textbooks will be forthcoming. This problem is of course particularly acute in minor languages like the Scandinavian, Dutch etc. These are also the reasons for the more or less uniformly negative response to questions on the usefulness of European co-operation in production of textbooks (cf. 6.6).

In overview courses which have an ambition to give students a fair amount of background knowledge on environmental problems the problems of finding literature of sufficiently broad coverage but of reasonable price and size are great. In longer programmes the lack of suitable text for introductory courses – such as the introductory options in the Trondheim and ESP 40 programmes – are also acute. Overview courses and courses which are open to a wide range of students of different academic backgrounds have the additional problem of not always being able to use texts in a foreign language – not even English.

At Trondheim the problem of lack of introductory material has been tackled particularly thoroughly. This programme was set up in a longer planning perspective than is usually the case. International experience from other programmes was gathered and production of texts begun in advance. In the ESP 40 which in many ways is similar in approach to the Trondheim programme texts have been produced in advance for one course – the one entitled "process technology" which was subsequently broken up. Other texts, both for the ESP 40 and the ESP 10, have been produced on an ad hoc basis in the development of the programmes. This has the advantage that texts can be modified on the basis of experience of students and staff.

The ESP 10 programme has a long-term publishing plan in which the aim is to cover the entire factual core of the programme. Texts are used for some time in the courses before being transferred to a commercial publisher. Most of the texts produced are used by the other Swedish universities which have similar courses. Texts are cheaply produced – offset printing and only line drawings as illustrations – and printed in rather small issues. This makes it possible to update the texts after about two years. This is often a major problem for textbooks in minor languages, particularly in the present publishing situation. So far texts covering elementary radiation physics and biology; genetics; technical methods of water pollution control; hydrology and aquatic biology have been published. A glossary of environmental terms (also giving the English translations) and a text on ecology and soil science are under production.

Many programmes have been started with some kind of conference or symposium and use the proceedings as a basic text. Examples are

the Amsterdam IWG, the Technical University (TH) of Vienna "Analytische Chemie und Luftschadstoffe" (Analytical Chemistry and Air Pollutants), and the annual conference Umwelt Saar (The Saar Environment).

The use of recommended readings rather than prescribed texts is of course more in line with the ideas about letting students develop their own interests. Examining literature lists one often finds that there are recommendations for good textbooks e.g. a choice of several modern ecology texts and some hints which may be helpful to the students' choice. When however the more speculative or controversial books are given there is often a curious lack of alternatives. The most striking is perhaps the absence of examples of the criticism of "The Limits to Growth" and the Club of Rome Report in lists which contain these (cf. 3.4).

The use of original scientific articles at the NUU is described in (4.8.4).

4.3 Teaching aids

The technical equipment available for environmental education varies enormously with size of programme, type of institutional organization etc. The ability to draw upon the resources of a large university may be more valuable than ownership of the equipment though the planning problems may be lessened by direct ownership of laboratories, field work equipment etc.

The production of teaching aids other than literature has not reached any significant proportions in any of the programmes. One reason may be that they are generally recent contructions and have been fully occupied getting organised. Most of them do not have the resources available for production of such material – unlike some US programmes (Pratt 1974).

There is as yet little commercially available material in Europe for university level environmental education.

In spite of the generally negative replies to the question of interest in European co-operation in production of teaching aids I suggest that there are some areas which could be tackled on the European level. Preparation of case studies on planning and pollution control is one such example. Others are production of core material for basic courses in mathematics (cf. 6.6) and natural sciences. An appropriate level may be within regions in Europe.

4.4 Examinations

In most cases these are relatively traditional to the respective systems studied. Their aim is to test the students' knowledge and

evaluate the student in relation to the body of facts dealt with during the programme. The evaluation of the programme itself is often neglected both in examinations and in other ways (4.11). There seems to be no difference in this respect between systems that have defined their goals mainly as giving knowledge and those which have incorporated behavjoural goals such as "changed attitudes", "willingness to integrate" etc. The problems of construction of examinations and their purpose are of course not unique to environmental education but it is perhaps surprising to see so little attention paid to these in programmes, which in other ways demonstrate the willingness to innovate and follow non-traditional ways.

In some instances the problems have been simply neglected and there is no form of examination or evaluation at the end of courses. This is in my opinion a non-solution to the problems of examinations in that important information on the effects of the programme is not collected. It may also be argued that all but the most superfical overview courses have a responsibility towards society to ensure a certain minimum amount of knowledge and that a number of students actually reach the set goals such as "changed attitudes", "willingness to integrate" etc.

The minimum of checking the student's ability to answer factual questions correctly is the goal of examinations at the ESP 10. It is given in multiple-choice form and the questions are strictly factual. This may perhaps give an indication of whether the stated goal "to serve as a basis for broad and objective public opinion making" is reached but certainly not so for the goal: "to teach the student to critically examine and relate knowledge of environmental problems to the social systems".

This illustrates the problems of evaluating education and students in relation to such praiseworthy but extremely ill-defined objectives. In the Swedish context the problems are particularly great since there is pressure on educational institutions to make examinations "objective", "reproducible" etc. This situation exists in varying degrees in other European countries and the use of factual, short questions or multiple-choice examinations can be considered as a retreat into an easily defended position. The element of logistics is usually also prominent. In short courses with large numbers of students the problems of handling any other form of examination may be insurmountable.

The organization of examinations may in other ways be contrary to the goals of education. Many systems formerly had massive examinations at the end of the entire academic studies i.e. after 3-5 years of studies. This presented obvious social and psychological problems and examinations have to varying degrees been broken

down. This has gone furthest in systems working with sequences of full-time courses in a credit or unit system where each course is examined separately and immediately at the end of each course. In a multidisciplinary programme made up of such courses the student is never asked to make any integration in examinations. Hypothetically a student may, during her studies, be asked the same question, but expected to reply differently depending on what course the question referred to.

In systems (such as in the UK) where examinations come at the end of longer periods of study the multidisciplinary programmes may have a problem of overlap and difference in approach to a problem. The method of examination in the UK should normally guard against this since a group of teachers plus external examiners and often a departmental head are jointly responsible. Organizational safeguards can also be introduced: "care is taken to rule out any overlap between questions in the different papers of the Final examination (each subject teaches to its own Finals paper)" (Clayton 1974).

The British system of examinations using essay papers and reading lists rather than prescribed textbooks would seem to have advantages from the evaluation point of view. It requires an open attitude and a high level of competence in the teachers who mark the papers. No students that I talked to in the UK expressed particular concern about the subjectivity of the method even when pressed on the point. This is somewhat surprising in view of the extremely general questions set for papers. One wonders whether a paper on "the limits to growth" would receive equal treatment if it were a review or a criticism of these concepts, in a course that has Meadows book but none of the criticism of it on its reading list. Many teachers that I spoke to were rather complacent on this point. The justification is difficult to judge.

4.4.1 *Assessment*

Project work, seminars and papers play a large role in many programmes. At NUU the trend towards assessing this work and basing classification of degrees on this rather than on examination papers has been carried far. The students are normally given a choice of whether they want to be judged by assessment of their work or on a combination of assessment and examination papers. Many students voiced a preference for this type of evaluation since "one reads more widely and more modern literature, such as scientific periodicals, rather than text-books". In this way assessment seems more in line with the behavioural goals of many programmes. The stress it places on the teaching staff must be considerable and the system would seem to require rather more resources than may be productive, for this aspect of education.

4.4.2 *Unconventional methods of examinations and assessment*

The problems of relating examinations to real problems and to the set goals of a programme have been given some imaginative solutions.

At Edinburgh one problem for students to solve is a management and development plan based on a dossier on an area. This will be made even more realistic by the addition of a short excursion where the area is presented to the students.

At Salford topics for papers have been to investigate citizens' attitudes to their immediate environment. For this and similar papers two days were given and students had free access to libraries etc.

In a course on conservation at NUU students were given four options for written assessments: conservation action; book review; compiling a bibliography and annotating it; making a flow diagram of the inter-relationship of man with his environment. The form of presentation of the conservation action could be correspondence with a government agency or company, letters to newspaper or press cuttings relating the action, etc.

It is interesting to note the attention given to examinations and assessment in the UK. This is perhaps natural in a system of graded academic degrees. In systems where "pass – fail" may be the only distinction less effort is often made in devising a varied system of evaluating student performance. This may create a more relaxed atmosphere for studies but probably also means less feed-back to the teachers.

4.5 **Motivation of students**

It is probably true of all levels of environmental education that motivation of students is far above average for post-secondary institutions.

However all multidisciplinary programmes have a special problem in making a plausible case to the students to accept the particular teaching offered. This is particularly true in programmes which have a substantial amount of introductory courses aimed at providing a foundation of knowledge. If a good case for these courses cannot be made to intelligent and highly motivated students, eager to come to a better understanding of environmental problems, I think that the organisers should ask themselves if it can be made at all.

The problem is greater in undergraduate programmes since students in graduate programmes and recurrent education normally have made a more conscious choice and know more what they need.

Many programmes should devote more time to explaining and motivating students if only for the simple reason of ensuring more efficient operation of the programme. Organisational models, which permit the students a greater freedom of courses, project work etc. are likely to be better to work within for students and staff alike. In programmes with large proportions of required studies more time could profitably be used to motivate students. Although many natural scientists have some idea of a logical order in which to arrange subjects into courses and programmes it is usually a good idea to let the student discover what basic skills and knowledge she needs. This need not be considered a wasteful process even from a narrow cost-accounting point of view since efficiency in learning increases greatly. Environmental programmes ought to be in a particularly good position to experiment in this field.

Various methods are in fact also used to this end. In thinking on these matters one should not forget the role of good basic information on courses to applicants, good introductory lectures and stimulating seminars (cf. 4.8.1). More unconventional ways may be the "confrontation" period of the overview course at Utrecht where students are exposed to many aspects of real planning problems in the Utrecht area, excursions, talks with action groups etc. for a two-week period. This arrangement was adopted when a more conventional course based on natural science (ecology) and social sciences, particularly sociology and planning, had failed to engage students from the social sciences who did not feel the relevance of the natural science component. However the sequel to this confrontation seems to me to be somewhat loosely organised and not to make full use of the possibilities. It was indicated as mainly group work to define and study the problems.

Following a similar idea I have sketched an idea for a course of 10 weeks aimed at giving graduate students of psychology an introduction to environmental problems on which they can bring their particular speciality to bear. This is given in appendix II. It should be noted that unlike the arrangement at some experimental universities the democratic ambitions of this course are not very great. The confrontation is designed to motivate students to study most of what is offered. Not all need take everything, and some additional teaching can be brought in if students specify that they want it. The nature of the course makes it necessary to plan much of the teaching in advance for reasons of getting teachers and making timetables etc. Most organisations have neither the resources nor the flexibility to arrange teaching to suit the needs of project groups as they advance into an area where they may identify a wide range of needed background knowledge. It should also be noted that it is an outline of a proposed course. At present it is taught along more conventional lines.

Other ways to motivate students and explain the structure of a programme are the introductory courses (UV de sensibilisation) at

Paris VII; the introductory residential of the Amsterdam IWG which should serve as an "explanation of the main theme of the course to assess the identity of the major disciplines involved".

Some programmes seem however to either ask the students to accept the ideas of the organisers on what is a necessary base or else to arouse them but then not really satisfy them. Both methods are equally deplorable: the student certainly has a right to good teaching, and the programme no right to demand that students accept everything without some explanation.

4.6 Information to prospective students

Most universities have not been very interested in informing prospective students on the content and organisation of courses and the students have been surprisingly undemanding as a rule. The drop in student numbers has changed this attitude somewhat. In general, environmental programmes seem to be better than average in this respect. Some particularly good examples of information material come from CESA, Salford and Plymouth – all three probably programmes which have a good reason to be conscious of the value of advertising. Not because of lack of applicants – all three have applicants in excess of intake – but because they recruit on a national basis and have an obvious interest in obtaining good students.

The normal procedure in many British universities is to interview candidates before offering them a place in a programme. This serves also as an extremely good method of informing the students and thereby helping them to decide on whether the programme is really what they are looking for. This was stressed not least by Dr. Taylor, Director of Studies at the Department of Forestry and Natural Resources Edinburgh where candidates are not interviewed for budget reasons.

If the competition for students gets keener through proliferation of programmes or a drop in interest there is a certain risk that information may turn into marketing.

4.7 Objectives of seminars, essay work and projects may be one or more of the following:

Guide the individual's studies (4.7.1)

Give realism to the education both in the matter of form and content (4.7.2)

Teach the student to work in depth on a problem using various techniques (4.7.3)

Teach the students to work in more or less integrated groups (4.7.4)

Include students in on-going research (4.7.5)

Teach students to present complex material in a form which is suited to various types of audiences (4.7.6).

4.7.1 *Guidance of the individual's studies*

Arranging under-graduate studies around a project, theme or problem chosen by the student is not as yet very common in European universities. It does exist in the form of course unit systems whereby a student may combine according to her own interests. In some experimental universities (Roskilde, Green Bay, Waterloo) the system has been carried further, with great freedom for students to specify – individually or in groups – their needs.

As one moves higher up in the academic system the method becomes more common and is dominant in doctoral studies; with the required courses and readings usually reduced to a minimum. Thus the method is used in Wageningen where the experience gained by students in their practical work period (cf. 4.9) is considered an important source of guidance for later specialised studies. In systems suchs as the King's College programme where students are given a common basis and asked to specialise later such experience gathered would seem likely to help them decide on their specialisation.

4.7.2 *Realism in form and content*

Environmental education is different from education in most subjects at a university in that problems are not created or identified within the intellectual framework of a scientific discipline. Society identifies the problems and it is the task of environmental education to describe or indicate solutions of the problem. It is therefore natural to use existing environmental problems in education. There are however many problems in the execution of this obvious task.

Some of the problems are institutional. These pertain to the large problem complex of interdisciplinarity. Some are rather trivial such as the tradition of individual work and assessment, traditions regarding the form that presentations of results may take, etc. These problems are trivial in the sense that they are easily identified. Being tied to institutional arrangements (often on a national scale) such as the degree systems etc. they may nevertheless be hard to change. The problems of "objectivity" of examinations, assessment of project work as hindrance to co-operation and integration are dealt with in 4.4.; 5.4.

Environmental education would seem to be in an extremely favoured position to avoid some of these problems. Having usually highly motivated students, staff that is likely to be open to unconventional ways of teaching and assessment (cf. 4.4.2), better than average student/staff relations, there seems to be a possibility to introduce a high degree of realism in form and content of practical work, even when there may be a conflict with institutional tradition. Even so there are major problems in the incorporation of realistic material into courses. This is particularly true in shorter courses since the collection of material, if at all possible, usually takes a long time and perhaps more effort than the problem merits.

Several solutions to these problems are used by programmes. Integrating students into existing research programmes (cf. 4.7.5) is one. Field work in areas where good background material is available is another. This is often particularly important when the field work is part of an effort to present management plans (cf. 4.8.6).

Realistic exercises using fictitious material in combination with real is used in varying degrees (e.g. in a NUU conservation option; used in examinations in Edinburgh cf. 4.4.2).

The use of case study seminars (cf. 4.8.2) is another method which has the drawback, in common with constructed problems, that the collection of additional material is usually not possible.

There is usually a problem connected with this kind of realism also in that it requires much time and effort in preparation. This is not likely to occur spontaneously unless well planned into budgets, the use of staff time etc. This kind of work is best developed in programmes which have been in operation for some time and have the institutional stability to produce material.

Since sources of material are usually outside the university the formal or informal contacts with society of the programme, staff and students are even more important than for most other types of university institutions (cf. 2.7).

Choosing problems judiciously for small courses may be more of a problem than many teachers and students realise in "young" programmes. Enthusiastic staff and motivated students can compensate for experience of this type of work only to a certain extent. This is obvious both from discussion with them and from examining project reports. At the beginning of programmes the learning experience from ambitious but badly chosen projects is probably greater for the staff than for students.

The competence of staff members is an interesting problem in relation to project work. This is particularly true in small programmes or programmes run by single departments where a co-ordinator will

normally be trained in only one or a few of the disciplines which are needed for the work. Institutional organisation or budget arrangements which allow the co-opting of other specialists are necessary if ambitious projects are attempted. For a discussion of one method of solving this problem see "group work" 4.7.4.

The ability to involve persons actually working in society with the problem studied either as consultants or even as tutors for such group work is deemed essential by most programmes. Professor Labeyrie (CESA) warns against this practice since he feels that the critical analysis of planning methods or whatever is studied will not normally come from such tutors. The degree to which outside help can be used is a matter of inclination on the part of the organisers of a programme, but mainly a function of budget arrangements and institutional organisation.

On the question of realism in form many programmes adopt ways of presenting the work of students in non-traditional ways. Examples are management plans, tenders for development contracts (exercise at NUU conservation option), formal proposals to regional or national agencies (proposal by ESP 10 students for the establishing of Sweden's first marine nature reserve), publishing as books or pamphlets (Southampton EM; Leiden). In some cases these unconventional forms have also been used in examination and assessment (4.4.2).

4.7.3 *Technical training*

To teach the student to use various techniques in describing and solving problems is of course the object of much traditional field, laboratory and essay work (cf. 4.8).

In many environmental programmes the object may be to make the student familiar with these techniques rather than proficient at using them. Most programmes which attempt to give a background knowledge of natural science use laboratory exercises more for this purpose and to give realism to the teaching. There is sometimes a conflict with students — particularly those from law, social science or economics — who consider experimental work a waste of time when the object is to make them familiar with the use of various methods and their limitations (cf. 4.8.5).

The use of mathematical methods, systems theory, simulation etc. as concepts for synthesis is dealt with in section 3.3 and 3.5. As tools of in-depth analysis they are important in several courses.

Particularly in undergraduate programmes it may be of importance to illustrate the power of the scientific in-depth pursuit of a subject as a complement to the training in synthesis, integration etc.

advocated in the goal definition of programmes. It becomes necessary to emphasise the need for a problem definition and the choice of suitable techniques in relation to the problem. This is often the rationale for having students in science orientation courses do laboratory and field work to get them to understand what questions can be answered by a particular method of investigation. More attention should be paid to this problem in most programmes. Many natural scientists have a tendency to overemphasise the collection of exact and detailed data. In many planning and management problems the need is often for rough estimates, broad coverage and compatibility with other inputs. Simulation exercises would seem a good tool to discipline teachers and produce an understanding of what data is needed in relation to a given problem (cf. 3.3.2).

A "technique" that is easily overlooked in favour of more glamorous ones is the ability to read. Essay work using original scientific papers from several disciplines is a cheap and effective method for training students to extract the information they need for a particular problem (cf. 4.8.4).

4.7.4 *Group work*

Most programmes emphasise that many environmental problems require group effort to describe and solve them. This is true irrespective of the level of a programme or the stand taken on the "specialist-generalist" issue. Certain programmes claim to educate co-ordinators or generalists who must be trained both in group work and in the techniques of "group leadership" (syllabus for C 1, CESA). Others aim more at training students to be members of a group (ESP 10 and 40). The integrative nature of group work is however stressed in most programmes.

In graduate programmes, adult education, extramural courses, professional training etc. where the students have a mixed background as regards education and experience this can be utilised by the programme. In the ESP 10 programme groups of 4-10 students work on a problem under the guidance of a tutor. The choice of project is from a range of subjects available or suggestions from the students at the beginning of the course. A great deal of effort is directed towards finding suitable subjects and tutors for mixed groups which can utilise the wide range of backgrounds of students. (Emmelin 1974a)

The assessment of students may be a major hindrance in the development of practical group work since it is usually impossible to define the inputs of the individual members. This is particularly true if the work has been successful, in the sense that an interdisciplinary team work has been achieved. It is sometimes claimed that students will work well only for projects that are assessed – particularly at the undergraduate level. This his not been our experience at the ESP 10

where many groups (including their tutors) spend more time than could reasonably be demanded of them because they are looking into real and important problems.

Though the British programmes are perhaps more interested in assessment there is a fair amount of group work in most. In some the problems of assessing truly integrated group work has led to a differentiation into two kinds of projects where the integrated group work is not assessed.

Several students of British programmes were of the opinion that group work can be integrated and still assessed. It seemed that these students agreed with many staff members who stated that integration cannot be carried to a point where the individual contribution is not recognisable. This was not the experience of other programmes – notably many of the shorter overview courses in the Netherlands, Sweden, Norway etc. The difference of opinion may stem largely from the fact that many of the British projects contain significant proportions of field or laboratory work where the individual contribution is recognisable even though it may not be so in the conclusions of the group.

4.7.5 *Including students in research projects*

In theory it would seem ideal to have students take part in on-going research programmes of departments. In practice it is often not feasible and may even be a waste of the students' time.

If the experience is to be of value to the student it would seem necessary to have special resources in the project for the guidance of students. In short programmes there is usually not enough time for the student to become sufficiently familiar with the programme and make her own contribution.

There is always the risk that courses become the source of cheap labour for a research project. To the scientists working with the project the quality of the scientific work is of course a primary consideration. To ensure this students are given small, well-defined and disciplinary pieces of work which are designed with little regard for the didactic value of the exercise. It may even so be a worthwhile experience for the student, particularly if it is intensive field work with a mixed group of scientists and students. The discussions that usually occur in field situations, the practical experience of methods etc. can be both valuable and stimulating to all involved.

The benefits to the scientific project and those working with it should not be forgotten. Having to instruct and explain the purpose, methods and results of a scientific project is usually good for the sciences to bear on what is termed "landscape evaluation" i.e. project and the extent to which much specialised knowledge, sophisticated techniques etc. are necessary.

One way to achieve a balance is the approach advocated by Dr. O'Connor (UCL) who saw student project work as an exploration of a theme which could be expanded into a research project. The University College Conservation Course Field Expedition to Mallorca is such an example of a combination of student project work and research by the organizing department.

At Utrecht several institutes co-operate in a pluridisciplinary project – the krommeijnprojekt – bringing biological and geographical sciences to bear on what is termed "landscape evaluation" i.e. providing the planning process with background material for land use and management planning. Students are integrated into this. Although their individual projects seem monodisciplinary they are well integrated in the sense that the aims and results of the project is discussed in seminars, there are publications on the project etc. The staff members were aware of the temptation to use students as cheap labour and what efforts are needed to make student participation worthwhile in a project where the aims are the results and not primarily the chance to teach.

The inclusion of students in existing research programmes would seem to depend then on the scientists making these points clear to themselves and to the students. Offered as one of many alternatives for project work it is likely to attract at least some students.

4.7.6 *Education in the presentation of material and communication*

Since many of the longer programmes aim at producing co-ordinators, people who can work in groups etc. and are able to communicate with experts, the presentation of material is stressed by many as part of the education. The degree to which the presentation of material is central to the aims of the programme varies. The King's College course outline seems to be one where this aspect has been carried far. A stated goal is to increase "the students' ability to communicate their ideas effectively in writing and speaking". To this end there is a special course: "a practical course in the preparation of environmental cases for oral presentation in various types of situations". It includes participation in discussions, techniques of public speaking, chairmanship, committee procedure, use of illustrative material etc.

Similar aims are stated by many course outlines but the degree in which there is formal education or in which the student is supposed to pick these abilities up in the course of other work varies.

The inclusion of foreign language training in the CESA programme is another example of formalised communication education in environmental programmes. Environmental education can also be useful in other lines of communication education – the Amsterdam IWG course has been taken by a number of students of the university interpreters school.

The assessment or testing of the degree to which courses attain the goal of better ability to communicate is a problem which seems to have been given little or no attention. This is in line with the general tendency in higher education of neither assessing students nor evaluating courses in relation to stated behavioural goals. In the case of communication it would seem feasible to do some testing of results which might be useful in developing courses.

The rule now is for staff members who are mainly scientists to evaluate and assess project reports, essays etc. The stated aim with respect to communication however is usually to teach the ability to communicate with the public or specialists in other disciplines. The British system of external examiners may give some indication of whether the student is able to communicate with a specialist in an adjacent field.

Evaluation by staff members of other departments, journalists, members of the professions concerned, politicians or a representative panel of the so-called public might give interesting results and useful hints for development.

In some cases student and staff are confronted with the people they aim at communicating with in the course of project work. This may be one of the greatest benefits of projects such as the Leiden group work, "Is the Leidse Baan really necessary?". This was a study of the plans for a motorway development and a proposal for alternative methods of transport and changes in regional planning in the Leiden area. Students and staff learned many practical lessons about communication since the project was conducted in an activist manner with the clear aim of getting the issue debated by planners and public. Whether such exercises teach students and staff to communicate or to persuade is not for me to judge.

4.8 **Forms of active learning**

4.8.1 *Seminars*

Most educational institutions use this term for discussions where students are supposed to take a more or less active part as leaders, critics of material presented, etc. The size of the student group should be small enough for real discussions between members of the group to be possible.

Most programmes stress seminars as essential and indicate several aims of this part of education – communication, use of original scientific material, and the possibility to bring up speculative or controversial issues in a less authoritarian way than lecturing. A very important criterion for a good seminar – which is hardly ever

mentioned – is that it should be enjoyable for all involved. The result of the ideal seminar is that all involved have a feeling of having learned something and simultaneously feel a desire to learn more. Thus this ideal seminar ends in a universal stampede to the library. The reasons for the extreme rarity of this kind of seminar are mostly too trivial to enlarge upon, well known to students, and teachers alike. Still I agree with Krebs (1972) that: "One of the mysteries of university education is the way in which dynamic and engrossing subjects are transformed into boring, static and tedious courses."

In environmental education one of the problems of success of a seminar is often the ambition of students and staff in the choice of subjects. The subject has to be chosen in relation to group size, background of students and staff etc. Common mistakes are to choose subjects where the discussion gets stuck on some rather simple factual or technical point because none of those present is competent enough. Topics are often too big so that the discussion wanders rather aimlessly. Time is often too short in relation to size of topic etc. These are really faults which most public debate suffers from. A technical solution which seems to help overcome these problems has been adopted by some of the Dutch overview courses. Each lecture is followed immediately by discussion in smaller groups. Some participating students have been asked to prepare themselves by studying the subject to be discussed. Thus there is both a certain minimum amount of common knowledge, additional sources of knowledge and a chance that questions and problems have been generated.

A special aspect of seminars is the speculative discussion which relates results of recent research. The following quote from Krebs (1972) would seem to be true for other subjects than ecology. "Students can learn far more about ecology by analyzing one of its controversies than by reading textbooks." Good seminars which pose unconventional questions may be a source of motivation in undergraduate courses and in the courses which attempt to teach a background in e.g. natural sciences to "outsiders". For – to quote the preface to Krebs' textbook once more. "If a person interested in ecology is bored by books on the subject, what hope is there for students in liberal arts, agriculture or chemistry?"

The need for a high level of competence in staff taking part in seminars is not always appreciated in the undergraduate courses or course which introduce subjects. The national traditions play an important role here. In general the British tradition seems to be the least authoritarian, with professors taking part in discussions, advising on essays etc. rather than just lecturing to students. Local arrangements may alter the traditional pattern. As pointed out elsewhere (4.1) staff: student ratios are important in deciding the amount and nature of the discussion that takes place.

The lack of analytical social science and the utilitarian (= dull?) aspect of that which does occur in many conservation and management courses has been pointed out (3.5.1). The seminar form may be particularly well suited to introduce both students and staff to social sciences, value analysis, etc. which are regarded by many members of such programmes (both students and staff) as speculative rather than factual. The breaking down of prejudices about other sciences is an important aspect of attempts at interdisciplinarity (with its concomitant risk of reinforcing them rather than breaking them down).

Finally it is obvious that those courses which have a high proportion of students from varying backgrounds – graduate courses, adult or continuing education etc. – are in a particularly favourable situation with respect to seminars.

4.8.2 *Case studies*

A particularly useful form of seminar is the one devoted to examining case studies. In attempts at interdisciplinary teaching on planning, management, conservation, development etc. recourse to well-documented case studies is invaluable. In this respect the British and Dutch are in a particularly favourable position with, respectively, the New Towns and the development of land claimed from the Sea. It is obvious that many programmes make good use of this material. The existence of organisations such as The Town and Country Planning Association in Britain with educational programmes is a great help since the preparation of well-documented case studies is usually a big undertaking for which many institutes do not have the resources – in particular in their first years. The ability to draw upon research done by the staff members or groups within the course-giving organisation is valuable.

Invaluable is also the existence of some source of experience of work in different environments, be it development in the tropics, irrigation in arid regions or arctic ecology. Examples of this are e.g. the "option in tropical environmental affairs" offered at Salford. Availability of sufficient staff for such options may also be important to make environmental education relevant for both foreign students and those who wish to apply their environmental knowledge in development work. A small attempt at bringing such experience into a programme is the authorisation, given by King's College to students who have been accepted for a degree course to delay starting their studies for a year to do VSO (Voluntary Service Overseas).

The use of case studies in development training is discussed in a paper by Thane Rhiney (1972). One of the lessons of Mr Rhiney's work is that great care must be taken in the preparation of cases.

It is very common for the discussion not to get beyond trying to superficially place the blame for mistakes on some single factor or person involved. A drawback of most cases on development is that the failures are better represented than the successes. A serious reconstruction and analysis of why decisions at specific times were taken, on what basis, the quality of information available and the reasons for missing information etc. should be carefully looked into. This is usually beyond the individual programme or tutor if first-hand experience gained by research or practical work is not available. The preparation of case studies in the ecological problems of development and pollution control would be a useful task for international organisations or independently funded groups (6.6).

An extremely useful source of case studies is The Careless Technology (Milton and Fahrvar 1972). Several of these well-documented cases of development problems can also profitably be used to illustrate principles of human ecology such as the major communicable diseases, the interaction of social and natural systems in determining success of development programmes, etc. Conceptually the principles of human ecology seem easier to grasp when parasites, diseases, crop pests, erosion problems of tropical countries are studied (cf. Newbould's comments on human ecology 3.4).

Forthcoming publications by Rhiney in which the case studies discussed by him in the paper in The Careless Technology are given are likely to be a major source of material. However on pollution control in Europe and the US no such material exists yet to my knowledge.

A drawback inherent in the use of ready-made case studies from literature is that it is usually not possible to collect further material. An important part of the exercise would nevertheless seem to be to ask students to specify what additional material they would like to collect and how they would go about it at various stages of the development of the case.

4.8.3 *Games*

The use of games, role play etc. in European environmental education is minimal. Some US educational institutions report succes with such techniques and at the school level various games have occasionally been used in European secondary education.

There are a number of commercially available games. Several of those dealing with ecological principles can be extremely sophisticated and would probably be quite useful in setting out these in introductory courses.

It would seem likely however that a certain amount of psychological resistance to "games seminars" would be found in most European institutions of higher education.

4.8.4 *Essays*

The use of individual essay writing is prominent in British programmes, particularly the undergraduate ones. Aims of this may be many – to teach students to communicate (4.7.6), extract information from original scientific articles, guide their studies and give an opportunity to develop their own interests.

At the undergraduate level one problem which has been tackled at the NUU is the fact that students with little experience of this kind of work need a starting point if they are not to spend an unreasonably large proportion of their time getting into the subject. A collection of reprints organised to provide readings for each course option is kept by the School of Biological and Environmental Studies. Papers in this collection form an easily accessible point of departure. Working with these and their references students get some guidance in their use of the University Library.

If contacts with society are frequent and operate well, a department can build up collections of useful material collected from agencies, industries, organisations etc. The ESP is continually building up such a collection. The assessment of essays is discussed in relation to communication in (4.7.6).

4.8.5 *Laboratory work*

The aims of laboratory work may range from original research in post-graduate programmes to the simple demonstration of phenomena or equipment in overview courses.

Many programmes of medium length (Salford, ESP 40, Trondheim) indicate that they have great difficulties in deciding on the amount and the exact aims of laboratory work. Partly the aim is to complement other methods in a project and the decision is then based on resources and time available. In basic science courses it is traditionally considered an integral part and there is good circumstantial evidence that most students learn the elements of these sciences better with a combination of lab work and other forms of education.

In short or medium size programmes the cost-effectiveness problem becomes acute. Laboratory space, and resources in the form of equipment, staff and expenses, usually limit the possible intake of students severely. It seems that in programmes of less than half a

year to a year this and other considerations tend to exclude laboratory work.

In programmes with students of varying backgrounds there is likely to be a difference of opinion between the natural scientist responsible for the lab work and the students from social sciences, economics, law etc. on the value of lab work (cf. 4.7.3). This seems to be particularly true for those exercises where the stated aim is to familiarize students with methods rather than make them competent at using them in an applied situation.

The interplay of theory and practice that laboratory work should create is often absent for the simple reason that sufficient explanation of the reasons for an experiment is not given. The instructor is all too often only concerned with the execution of the experiment. In fact the instructor has not infrequently fallen into the trap described by Clayton (1973): "a danger is that the student will equate scientific achievement with the successful performance of a laboratory exercise – if that is where the only skill lies we might as well teach them to cook."

4.8.6 *Field work*

The possibility of undertaking field work is of course essential in all environmental programmes. Again, aims are many and techniques vary.

The purpose of field work in natural ecosystems can have two – not exclusive – purposes: either to give first-hand experience of the system itself or to illustrate some ecological principle or particular aspect of the system.

Gaining first-hand experience of representative ecosystems is of course particularly important to conservation and management programmes. There is usually in these a range of required or optional field courses in a variety of systems. The inclusion of field courses on several ecosystems is also vocationally necessary in these programmes since training managers for only one ecosystem in a programme is hardly feasible or desirable (the nearest to this approach is the traditional education of foresters).

Applying one's skills to a management problem in a different or foreign ecosystem must be an extremely useful exercise in that it shows what part of one's knowledge is of a generally applicable kind and what are the needs for collection of material. This to varying degrees are the aims of the UCL Mallorca field expedition, Southampton EM and Plymouth field work in Wales, and the proposal for international co-operation made by Labeyrie (1972). This proposal is dealt with in (6.4).

As a complement to the Salford course there are plans that the field work of students from tropical countries should be carried out in their home countries. The large proportion of staff with good contacts in research institutes in the tropics is the basis for this planning.

The existence of the Field Studies Council in Britain is an important aid to programmes. The Council's centres can provide staff, accommodation and equipment, which greatly increases the efficiency of field work. Scientific field stations are to a varying degree available in other countries.

The efficient use of time during field work is ensured in several ways. Provision of good documentation on the area, problems to be studied etc. is one way. An example is that given to students at Plymouth, which contains several papers on aspects of the area in Wales – population and development of Swansea, geology and ecology of areas, papers on reclamation of mining land etc. plus detailed excursion guides, and itineraries.

Preparation beforehand and writing of reports on projects carried out is well formalised in tutorials etc. in the Southampton and Plymouth courses for example.

The use of field work in realistic management exercises where other data are fictitious has been mentioned. This is one way of giving realism to case-study-type work in that students have to show that they can collect, process and integrate results from field work into some context.

Present British plans for urban studies centres should be of particular interest to environmental education.

Field work may be an extremely useful method of bringing out the differences in approach of the contributing sciences and trying to achieve a measure of integration. Newbould (1973) describes the problem thus: "Compare for example university lecturers in geography, plant ecology and animal ecology of a day's field outing; the scale of their operation may be; geographer km^2; plant ecologist hectare; animal ecologist m^2.

This difference, seldom explicitly recognised as existing, may colour their respective attitudes to field problems. Suppose the problem involves the establishment and management of a country park, perhaps 50 hectares in area. To the geographer it may be a small part of an environmental complex, to the plant ecologist a unit containing two or three main plant associations and to the animal ecologist a complex pattern of a hundred or more discrete animal habitats. To these outlooks must be added those of the economist, sociologist, planner, landscape architect, civil engineer, park superintendent. Each has his own terms of reference, textbooks, concepts

and so on. Synthesis in conceptual terms is difficult if not impossible (cf. remarks on role of ecology 3.4: my insert). But synthesis in practical terms – carried out on the site, arguing for example about management, confronted with a real tangible problem – is not only possible but helpful to all concerned. I attach great importance then in environmental science to multidisciplinary field studies concerned with real problems in a defined area approached from the standpoint of several traditional disciplines."

4.9 **Uses of student project work**

The uses to which project work can be put vary greatly. Some have been indicated in relation to research programmes (4.7.5). There is a wide range of examples of other uses that student projects have been put to. The Leiden case which stimulated discussion on regional development was mentioned in (4.7.6). A proposal for the establishing of Sweden's first marine nature reserve was made by students of the ESP 10. Good student projects are regularly published in the bulletin put out by CESA: Cahiers du CESA. One thesis from Southampton EM has been published in book form. Most programmes can add to this list.

Except for those programmes which have students participating in research surprisingly few programmes seem to plan their project work with other uses in mind. Exceptions are e.g. Leiden and Utrecht where participation in local and regional planning is an explicit goal and at the ESP 10 where the uses depend more on the interest of students or staff, who propose a certain topic.

4.10 **Practical work periods**

One way of integrating practical experience into programmes is to have periods of obligatory practical work during the studies. This has long been used in engineering education in many countries. In CESA and Wageningen they are used with reportedly good results. Organisation of such periods requires that the programme has paid attention to its external contacts so that a range of suitable jobs can be offered to students. The "operations map" in one of the CESA offices showed many coloured pins spread over the entire country and a wide range of jobs in planning authorities, industries, pollution control agencies, etc.

The practical work periods in both these programmes come at the middle level (approximately Masters level). In CESA the average length is 10-12 weeks and in Wageningen 6 months, usually split into two periods at different places. From the programme point of view

the PR value was considered great. Many students get jobs in the agencies in which they have worked, according to several Wageningen staff members (no statistics were available). A further value reported from Wageningen is that the work tends to give direction and motivation to further studies.

A scientist from the research organisation of the Dutch utilities gave as his estimate that most host organisations consider it a valuable chance to test people for jobs, and that time spent in instructing the visitor is about balanced by her contribution if the period is of a month's duration or more.

The positive experience of CESA, Wageningen and other programmes that include practical work of this kind and the encouraging results of environmental recurrent education (Southampton EM), sandwich courses (Aston) and parttime courses (ESP 10) seem to me to indicate that undergraduate programmes should make an effort to formalise practical work periods. Since it already occurs on a large scale through student holiday work a simple method might be to set up a service which helps students obtain relevant holiday work. This is a further area suitable for international co-operation since the experience may be even more useful if gained in a foreign country (cf. 6.5).

4.11 **Evaluation of programmes**

As has been pointed out (4.4) most programmes show relatively little interest in evaluation. This is in line with a general trend in post-secondary education which some ascribe to complacency on the part of universities. In environmental programmes, which as a rule show a high level of willingness to experiment and an open attitude to pedagogic innovation, it is my experience that the lack of formalised evaluation of courses stems from a realisation of the difficulties of meaningful evaluation. Most traditional attempts at evaluation give little useful information to those teaching or organising a programme which is not available to them from good student contact anyway. The problems of evaluating students in relation to behavioural goals of programmes has been touched upon (4.4; 5.4). The problem of evaluating a programme in this respect is probably further motivation for the experimentation with unconventional methods of examination and assessment (4.4.2).

More sophisticated evaluation of courses is usually outside the competence of those organising and teaching, far beyond the available time and resources of programmes. In 4.7.6 the problems of evaluating students in relation to a particular behavioural goal are dealt with. An experiment along such lines might also yield some

useful information for the organisation of programmes. Systematic outside evaluation of programmes would be interesting if sufficiently sophistically methods are employed.

At present, and given the constraints imposed on programmes, I would agree with those who claim that small groups of students, close and informal contacts between students and teachers, the use of external examiners and other such unsystematic methods are likely to give more useful information than questionnaires, surveys and such methods.

5. INTERDISCIPLINARITY AND INTEGRATION

The term interdisciplinarity recurs in programme descriptions. It is often used loosely to denote what should be called pluri- or multidisciplinarity (cf. 0.2).

Interdisciplinarity or variations such as integrative ability, integration of subjects, synthesis etc. is a goal of programmes both in relation to content of teaching and behaviour of students and staff. It is perhaps the most interesting methodological problem of environmental education. Since it is quite clear that form and content can not be separated, some points are brought up here under the common heading of interdisciplinarity.

5.1 Methods of achieving integration

In the simplest case students are exposed to many disciplines and left to integrate as well as they can. This need not stem from lack of pedagogical ambition. It is often a realisation of the problems of achieving a convincing integration between staff members working in different disciplines, with limited time available for integrative efforts. In those cases where research is believed to be the only viable road to interdisciplinarity this approach is prevalent (cf. 2.6).

The method of letting students do much of the integration is probably most effective in post-graduate education where a basis of knowledge of one or more disciplines exists (cf. 1.6). In relation to the behavioural goal of creating an attitude of integrative willingness the problem of the sequence of broad and specialised studies is often brought up. It is claimed that if students have a specialised undergraduate education the process of rigidifying has already begun – or perhaps even gone too far (1.6, 1.3).

If integration is left largely to students some things must be kept in mind. The first is simply to inform students of this fact. There is a quite common attitude among students that many programmes have a large amount of overlap in the teaching. On analysis this is often found to refer to the fact that different speakers have dealt with the same problem from different angles.

In programmes with a large amount of outside people coming in for short periods, visiting lecturers from organisations etc., some kind of coherence must be given in tutorials, by having a staff member sit in on lectures or by seminars which attempt this integration. The attitude to integration and interdisciplinarity is determined by the organisational origin and construction of programmes (2.2). This is

one of my reasons for advocating the "school of environmental sciences" or "programme co-ordination" in preference to co-operation between a few existing departments. The former is particularly important since it affords an opportunity to couple research with teaching. If recourse is had to programme co-ordination, the body set up to co-ordinate must have powers to specify what it wants from individual institutes and teachers in order to ensure a measure of co-operation and integration between staff (2.1).

A specific problem in environmental education is the lack of suitable textbooks for the medium-length courses. This is particularly problematic with respect to efforts at integration since the use of existing specialised textbooks is a further load on students to try to integrate from fragmented material (4.2).

It seems likely that a measure of integration exists in the pluridisciplinary programmes between related disciplines concerned with conservation and management. Even so there are great problems here, as pointed out e.g. by Newbould (1973) quoted in section 4.8.6.

In some of the multidisciplinary overview courses little integration is attempted since these programmes often aim at giving a broad coverage of different aspects of environmental problems. Some however make use of unifying themes. One example is the Oslo course which views problems in a historical perspective.

The use of unifying concepts is generally aimed at giving coherence to a multidisciplinary programme. In some instances I have a feeling that these concepts are not as unifying as they may seem. The use of energy as a concept may in fact mean that information which cannot be made compatible with the concept is disregarded rather than integrated – cf. Abillon's comment on social sciences (3.5.1).

The need for integration between particular disciplines was discussed in 3.3.2 in relation to systems theory as a unifying concept. There is however a need for confrontation between these disciplines also (cf. 5.5).

5.2 **Problems of staff in relation to integration**

The number of teachers involved bears no obvious relationship to the level of interdisciplinarity achieved, as pointed out by Clayton (1974). In undergraduate education many pluridisciplinary courses can probably be taught by a small number of staff members. Given sufficiently broad education of these the approach of different disciplines and the common concepts can be illustrated by one person.

If a large number of persons are involved multidisciplinarity will result, but not necessarily interdisciplinarity. If the resources of a programme allow, a method of getting integration advocated by many educators is joint teaching by two or more persons. This may take the form of sitting in on lectures or joint projects, field work etc. Due to lack of time and money this method is not practised as much as most programmes indicate that they would like.

Those programmes which involve a significant amount of people from outside the university face a special integration problem. There is perhaps not a great problem in relation to certain types of guest lecture i.e. those aiming to give the views of a special agency or industry on their own work. When larger and more fundamental contributions are wanted there is certainly a problem, which exists also in relation to contributions made by other university departments. In part many of the problems stem from lack of real co-ordination, whether this be caused by insufficient instruction or a lack of interest in adapting to a programme by the contributor.

One method of integrating persons outside the university is to involve them in the planning of a programme (CESA). This has beneficial effects both on the orientation of the programme and on the sense of responsibility to the programme felt by the outside expert. The close co-operation with outside experts would seem to be most important in programmes of the complementing kind (1.4.4) and in management-oriented programmes which train students for a rather well-defined labour market.

It has been the experience of the ESP 40 that in certain cases an outside expert with a good academic background is better able to specify also the more fundamental aspects of a particular course. There is of course always the risk that people involved in agencies will look less towards background knowledge and more towards more ephemeral skills.

The problems of the education of staff members have not received much attention. Since staff members are normally traditionally educated there would seem to be a need for further education of them also (some claim that a process of de-education is what is really needed).

Amsterdam IWG have tackled part of the problem by appointing former students as discussion leaders in seminars on the assumption that these people represent a "first generation of interdisciplinarians".

5.3 Practical work

It is the view of many educators that interdisciplinarity can best be achieved in research. Some even claim that this is the only viable method (Clayton 1974).

Without entering into this complex problem I would agree that following a problem wherever it may lead is likely to be a stimulus to interdisciplinarity. The use of various forms of practical work is felt as a most important component of most programmes, be it field work, excursions, involving students in research projects etc. These questions have been dealt with in 4.7 and 4.8.

5.4 Examination and assessment

The procedures adopted for examination, assessment and essay work are often contrary to the stated goals of a programme in that the procedures favour individual achievement whereas the programme may often claim to educate people in co-operation. The problems would seem particularly great in the UK, with its system of classified degrees. These problems were discussed in 4.4 and 4.7.4.

5.5 Dangers of integration

The integration of subjects is usually seen as a good in itself. It may be a far off goal but it is definitely considered to be one. For perhaps obvious reasons less attention is paid to the dangers of interdisciplinarity. In an attempt to present a coherent picture of a problem the temptation to oversimplify it is however great. The holistic approach is often simplistic.

At present there is I think a real need for confrontation between a number of disciplines. In section 3.4 the problems of an ecological approach were discussed. One particular problem – the compatibility of ecological inputs into engineering and planning – was raised. In environmental programmes there is a tendency to disregard this, ridiculing or lamenting the attitudes of "technocrats", "bureaucratic planners" etc. who fail to listen to ecologists. Similarly engineers often belittle the use of ecology as a science relevant to environmental technology and pollution control. Only rarely are these views confronted in front of a student audience. Such confrontation would perhaps force the parties to come to grips with the problem rather than denying that there are quite serious problems of compatibility, which do not stem merely from the incompetence of the opposition.

In one programme (Pro Deo) there is such a realisation. A deliberate choice of teachers who hold conflicting views is made. The risk of getting a non-productive exhibition is obvious. I would agree with Newbould (1973) that practical work i.e. field work is probably a better way to arrive at such a confrontation (cf. 4.8.6). The results of a successful confrontation may well be, not a consensus on concepts but at least an appreciation of the problem and some consensus on practical solutions to a given question.

6. RECOMMENDATIONS FOR CO-OPERATION

In this study a number of questions on the possibility of international co-operation on environmental education were asked of both teachers and students. The following is based on such discussions.

6.1 Curriculum development

An almost uniformly negative response to the question of whether the development of a European common curriculum should be undertaken probably stems both from a realisation of the practical problems and – more fundamentally – from an appreciation of the need for a diversified approach to environmental education. In certain fields where education leads to well-defined jobs e.g. medicine a measure of international compatibility is probably desirable. In environmental education one is dealing with a multitude of problems, varying environments etc. within a country and there seems to be no national standardisation.

The concept of European Curriculum Reform Centres promoted by the Council of Europe could however be modified to suit the particular needs of environmental education. There is a great need for information on details of courses, teaching methods etc., which is genuinely felt by many educators. There is also a need for international exchange of students and staff (recommendation 6.3).

The recommendation is therefore to consider carefully whether a Curriculum Reform Centre should not be designated and given resources to promote the exchange of teaching staff – in particular that portion of staff which is involved in the organisation and development of programmes. Some of the further recommendations for information exchange could also be carried out by the Centre.

6.2 Information on environmental education

The Curriculum Reform Centre or another appropriate body could organise the collection, translation and exchange of information on courses in Europe, on new developments in existing courses, on experience gained in different programmes. The methods of dissemination could be variable i.e. exchange of staff, regular or ad hoo seminars, the publication of a newsletter. To minimise costs for distribution of news it may be possible to make an arrangement with other bodies within the Council of Europe or with a national organisation in a member country which already publishes some kind of journal with a wide circulation. Co-operation with some organisation concerned with conservation would seem most natural if an agency outside the Council is sought.

A series of regular seminars on environmental education could be conducted either at the Curriculum Reform Centre or – perhaps better – at some of the major European environmental education centres. In the latter case the seminar could concentrate on studying the host organisation. A series of such seminars using some of the cases in this study could be as follows:

overview courses with an intake of students of varying backgrounds (Amsterdam IWG)

undergraduate education (Plymouth Polytechnic)

extramural, recurrent education (Southampton)

planning and management (CESA, Tours)

undergraduate education through to doctoral research (Wageningen)

conservation and natural resource management (Edinburgh).

NOTE: This proposal has not been checked with any of the above–mentioned universities. It is intended as an example of a seminar series which would be of wide interest to environmental educators.

6.3 **Exchange of students and staff**

The benefits of exchange for somewhat more extended periods than seminars or visits to study and discuss curriculum problems are quite obvious in all higher education and research.

In this respect two special problems have been brought to my attention. One is that many programmes are short on staff. If one of their core members is away for any reason the programme is in serious trouble. An international exchange programme which makes it possible to replace a staff member with someone of similar expertise would be particularly useful. In relation to student exchange the problem of getting credit for work done in other institutions and countries is a general problem. If a Curriculum Reform Centre were established the information gathered by the Centre could be used by programmes wishing to establish exchange of students and deciding on credits. A series of seminars conducted by and on individual programmes would obviously help in establishing firm contacts which are essential if student exchange is to be rewarding.

6.4 **Regional centres**

In a paper presented to the Committee for Higher Education and Research of the Council of Europe professor Labeyrie proposed several types of international co-operation. One particular area has evoked a uniformly favourable response. This is what Labeyrie terms

"co-operation resulting from the existence of certain types of areas" (CCC/ESR (72) 79). An exchange of students and staff between university institutions, field stations etc. studying problems related to a particular environment is seen as beneficial in many ways. It gives experience of applying knowledge in a new situation. It is in effect also an international division of labour which makes use of existing specialisations and increases the value of these.

Such co-operation exists on a regional basis e.g. in the Nordic countries where the Nordic Collegium for Terrestrial Ecology is extremely active in organising a wide range of advanced courses of a week's duration. These utilise existing research groups, field stations, interesting areas etc. The organisational model – a group of experts which meets regularly but not too frequently, a small secretariat based on an existing institute and ad hoc courses organised by an expert in the particular area – is very efficient in terms of unit cost. An important feature is that participants in courses have travel and expenses paid by the collegium.

The recommendation in this area is that the possibility of organising both permanent exchanges between centres of special environmental interest and ad hoc courses on a wide range of environmental problems should be further studied with a view to starting such work in the near future. The secretariat for ad hoc courses may be based on the Centre for Curriculum Reform.

6.5 **Practical work**

It has been repeatedly stressed in this study that many programmes attach great importance to practical work. It is also clear that the behavioural goals of many programmes include the ability to apply knowledge in a new situation. In some countries there are arrangements for practical work periods within the course (CESA, Wageningen), while certain programmes utilise practical experience of students (Southampton, ESP, Aston) in other ways. In engineering education practical work periods have played an important part in some countries and the opportunity to work in a foreign country has been provided. It would seem very valuable for environmentalists to have a similar opportunity.

It is proposed that the possibility of arranging for students to do practical work of some months, possibly during holidays, be investigated. As a minimum, information should be made available as to the opportunities. If feasible, an organisation which actively guides and helps students to find jobs should be set up. Information on these matters could be coupled to the curriculum information discussed in 6.1.

6.6 Teaching aids

As pointed out there is little interest in standardising curricula. For similar reasons there would seem to be little use for co-production of material at a European level. However it has become my conviction that two kinds of international production of material would be useful.

The most obvious problem in co-production is compatibility with a national curriculum. In higher educations the specifications regarding material are usually so stringent that it becomes difficult to achieve consensus without losing depth.

Two areas would not seem to suffer from this problem. One is the basic mathematics needed by many programmes. In section 3.5.7 some of the characteristics of the mathematics useful to environmental problems are briefly dealt with. At present it seems likely that texts and exercises devised by a suitably composed international group of experts would have a chance of being much more user-oriented than anything that can be produced on a national scale. The reasons are mainly the scarcity of suitably trained and suitably inclined experts in this field in many countries. The adaptation to national needs would be confined to translation, which could be left to national agencies.

It may be possible that similar areas could be identified in, for instance, the basic natural sciences.

The second area of profitable co-operation has the opposite characteristic of the above. Many problems of the environment are clear-cut, for a variety of reasons, in a particular country. The compilation of well-documented case studies on environmental issues would be useful in teaching at several levels. These should contain not only a good description but analysis from several angles. For the natural sciences such case studies would afford an opportunity to study good, clear-cut examples of a certain principle. For the social sciences suitable case studies would make it possible to extend comparative analysis of problems and the ways in which different social systems attempt to deal with them. To make case studies valuable it would seem important to have independent groups of scientists compile and analyse them.

In summary: two kinds of co-production of material is proposed – in areas independent of compatibility problems, particularly mathematics, and detailed case studies of environmental problems.

APPENDIX I: References

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APPENDIX II: Selected examples of programmes

COURSE OUTLINES

There are great variations in detail given. This is a function both of the detail available in descriptions and of a deliberate choice. Short descriptions are used to indicate some general principle referred to in the text of this study.

One example is given in great detail — the programme from Plymouth Polytechnic — both as an illustration to a well planned programme and to illustrate a programme more fully.

The arrangement is according to alphabetical order of countries. In brackets the abbreviation used in the text is given.

AUSTRIA

Technische Hochschule (TH) in Wien/Technical University of Vienna:
Overview course
Sandwich course in water pollution control

BELGIUM

Faculty of Agricultural Sciences, University of Louvain
(Louvain)

DENMARK

University of Copenhagen: Biological environment control line
(Copenhagen)

FRANCE

University of Paris VII: Environmental study
(Paris VII)

University of Tours: Centre for Higher Studies in Resource Management and Physical Planning
(CESA)

FEDERAL REPUBLIC OF GERMANY

Technical University, Berlin: Technical Environment Protection
(Berlin)

ITALY

Pro Deo International Free University of Social Studies, Rome:
Training course on environmental policy
(Pro Deo)

NETHERLANDS

University of Amsterdam: Programme of Interfaculty Post-graduate Course on Environmental Management
(Amsterdam IWG)

Technische Hogeschool te Delft/Technical University of Delft:
Introduction to Environmental Science
(Delft)

University of Leiden:

1. The Creation of National Nature Reserves in the Netherlands
2. Spatial and Social Development in the Leiden-The Hague-Delft Region.

Technische Hogeschool Twente/Technical University of Twente at Enschede: Programme of Environmental Engineering in the Chemical Engineering Department
(Twente)

Landbouwhogeschool te Wageningen/Agricultural University of Wageningen: Programme in Environmental Sciences
(Wageningen)

NORWAY

University of Oslo:
(Oslo)

1. Overview course "Man and Nature"
2. 1-semester Environment Seminar Programme

University of Trondheim:
(Trondheim)

1. Overview course given by the Institute of Technology
2. 1-semester Programme

SWEDEN

University and Institute of Technology, Lund:
(ESP 10 and ESP 40)

1. Environmental Studies, 10 points Programme
2. Environmental Studies, 40 points Programme

THE UNITED KINGDOM

University of Aston in Birmingham: BSc (sandwich) course in environmental health
(Aston)

University of Edinburgh, Dept. of Forestry and Natural Resources: BSC Degree course in Ecological Science
(Edinburgh)

King's College, University of London: School of Human Environmental Studies
(King's)

University College, University of London: Postgraduate Course in Conservation
(UCL)

New University of Ulster, Coleraine: Environmental Science
(NUU)

Plymouth Polytechnic: BSc (honours) in Environmental Sciences
(Plymouth)

University of Southampton, Dept. of Extra-Mural Studies (EM); Certificate Course in Environmental Science
(Southampton)

University of Salford: Environmental Resources Course
(Salford)

AUSTRIA

TECHNISCHE HOCHSCHULE WIEN
TECHNICAL UNIVERSITY OF VIENNA

Plan for overview course (A:1)

title	no of hours
Environment protection and ecology	4
Environment protection and economics	4
Environment protection and physical planning	4
Environment protection and law	4
Environment protection and process technology	4
in addition each student will take two of the following courses:	
Environment protection and air	4
Environment protection and noise	4
Environment protection and solid waste	4
Environment protection and water	4

Sandwich course in water pollution control (A:4, C:c)

1. Technology and environment. (This course is common to all the sandwich courses leading to a higher diploma. It aims at giving a common background to environmental problems, the interaction between air, water and soil; all major environmental problems are presented and a background in the law and economics of environment protection is given.)
2. Chemistry of water – effluents and natural waters.
3. Biology of water – effluents and natural waters.
4. Hygiene and limnology.
5. Geology and hydrology.
6. Physical and chemical methods of water treatment and effluent treatment I.
7. Physical and chemical methods of water treatment and effluent treatment II.
8. Methods of water supply and distribution.
9. Biological methods of effluent treatment.
10. Basic methods of sludge treatment.
11. Technical and hydrological methods of sewerage.
12. Industrial effluents.
13. Biological, physical and chemical methods of solid waste treatment.
14. Deposition of solid wastes.
15. Composting and incineration of solid wastes.
16. Methods of collection of solid waste.
17. Special problems in effluent treatment and solid waste management — radioactive wastes, thermal effluents etc.
18. Legal, administrative and business problems in water supply, effluent treatment and solid waste disposal.

Each one of these courses comprises 30 hours and has a duration of one week. A programme consists of 4 courses per year and runs for 3 years = 12 courses. Three specialisations are possible when choosing the 12 courses out of the 18 offered: water supply, effluent treatment and waste disposal.

The above course programme is one of three diploma programmes proposed. The other two are concerned with noise and air pollution respectively.

The programme is open to anyone with a first degree.

BELGIUM

ENSEIGNEMENT DE SECOND CYCLE "ENVIRONNEMENT – POLLUTION" A LA *FACULTE DES SCIENCES AGRONOMIQUES* DE L'UNIVERSITE DE *LOUVAIN*.

1. *COMPLEMENTS EN SCIENCES DE BASE:* Programmation FORTRAN (30). Statistique approfondie et biométrie (90). Recherche opérationnelle (75). Chimie, physique (60). Biochimie (60). Microbiologie (75). Agronomie générale (45). Economie (75).

2. *ELEMENTS CONSTITUTIFS DE L'ENVIRONNEMENT:* Météorologie et physique du globe (30). Chimie et biologie de l'eau (45). Pédologie (75). Physique du sol (60). Biologie du sol (30). Ecologie générale (90). Ecologie animale (55). Faunistique * (45). Ecologie humaine * (30).

3. *L'ORGANISME VIVANT DANS L'ENVIRONNEMENT:* Physiologie générale (60). Toxicologie humaine, animale et végétale (60). Hygiène de l'environnement *(15).

4. *POLLUTION:* Analyse des agents polluants (90). Compléments de toxicologie et phytopharmacie * (75). Pollution de l'air (40). Pollution de l'eau (45). Pollution du sol (40). Déchets solides (30). Problèmes particuliers de pollution (30). Questions spéciales de pollution de l'air et de l'eau (30). Séminaire de génie chimique : Pollution atmosphérique * (30). Technologie du travail * (15).

5. *BASES DES DECISIONS EN MATIÈRE D'ENVIRONNEMENT:* Séminaires pluridisciplinaires (150). Bases économiques des décisions en matière de pollution (30). Analyse coût-avantages (séminaires) * (30). Théorie de l'evolution des projets publics * (30). Aspects juridiques de la pollution (30). Aspects agronomiques et pédologiques de l'aménagement des territoires * (30). Aspects économiques de l'aménagement des territoires * (30). Aspects financiers et budgétaires de l'aménagement des territoires * (30). Aspects juridiques de l'aménagement des territoires * (30). Géographie humaine appliquée à l'aménagement des territoires * (60). Aspects sociologiques de l'aménagement des territoires * (60).

6. *TRAVAIL DE RECHERCHES PERSONNEL:* Travail dirigé par un ou plusieurs spécialistes (300).

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* Cours facultatifs ou en option

DENMARK

University of Copenhagen. Biological environment control line.

Year 1: Mathematics, Physics, Chemistry, Botany, Zoology

Year 2: Physics, Biochemistry, Botany, Zoology

Year 3: Cell-biology, Microbial ecology, Ecology, Plant-physiology

Year 4: Ecology, Hydrobiology and water analysis; Law and planning; Technical hygiene

Year 5: Specialisation and project.

A number of compulsory ecological summer courses of 3 weeks are included.

This programme is a reorientation of existing biology education rather than an environmental programme. It aims at producing biologists who can integrate into teams of environmental specialists.

FRANCE

Environmental Study at PARIS VII.

1. *1st cycle*

a) Pedagogic organisation
- — "Sensitizing" period at the start of the course.
- — Field-training periods more intensive than hitherto.
- — Integrated education as far as possible.
- — Part of the practical work for the various credit subjects organised "in the field".

b) Organisation of teaching programme (both years):
20 UVs (credit subjects) in all

- — 6 "sensitizing" UVs to be offered as soon as possible to all first-cycle students at the university:
  - — CC 141: Introduction to Ecology
  - — CC 241: Elements of Ecology
  - — GG 131: Water
  - — GG 231: Air
  - — QA 106: Thermodynamics and Energy Transfer
  - — GG 151: Application of Thermodynamics to the Environment
- — 6 training UVs independent of the main subjects chosen by the student (see below):
  - — GG 141: How human societies function: I
  - — GG 241: How human societies function: II
  - — NN 103: Methods for mathematical analysis
  - — SA 101: Introduction to statistics

— 8 analysis UVs in one of these three main courses to be chosen by the student:
  — Rural and urban ecology, biology, population genetics
  — Energetics
  — Pollution, nuisances, medicine, toxicology and the food industries.

There will be one consolidation UV in each main course.

— Two compulsory field courses: GG 199 and GG 299 which carry no specific credits.

2. *2nd cycle*

a) First year

The same for all students, with three main courses:
  — Rural and urban ecology, biology, population genetics
  — Energetics
  — Pollution, nuisances, medicine, toxicology and the food industries.

The courses deal with analysis and practical measures.

b) Second year

There are two complementary activities:
  — The preparation of several collective reports
  — Participation in multidisciplinary seminars (from one to three) in which students present and discuss the results of their research and the problems and difficulties they have encountered. Students must attend all seminars.

University of Tours

Centre for Higher Studies in Resource Management and Physical Planning (CESA).

Content of first study cycle

The first study cycle is divided into five main sections:

a) Auxiliary subjects related to the fundamental sciences:
  — Physics: energy, kinetic theory of gases, thermodynamics, electrical and electro-chemical phenomena;
  — Chemistry: structure of matter, principal chemical functions, colloids, amino-acids, proteins, chromatography, infra-red analysis;
  — Mathematics: ordinary functions, ordinary differential equations.

The purpose of these courses is naturally to teach students certain concepts that are essential for understanding the environment, but also, and perhaps principally, to accustom them to the logical and close reasoning necessary for all their future work;

b) Basic data concerning the ecosphere: this subject covers particular aspects of the ecosphere, viz. the air, the soil, underground structures, water, producers, consumers, reducing agents and human physiology. It is traditionally a part of geology, physical geography, soil science and biology, and enables the student to learn which are the parameters for physical factors and the behaviour of living things;

c) Basic data relating to human activities: man (population, natural movement and growth, mobility, working population) and human societies (social, socio-occupational and cultural structures) economic activities: distribution factors (energy, raw materials, communications); a grounding in economics and law. These subjects explain the constraints imposed by man's past and present activities on any action affecting the man-made environment;

d) The relevance of all the above studies is made clear by general courses which knit together everything related to the functioning of the ecosphere, of ecosystems and of the different types of man-made environment. The courses help the student to understand the part played by the factors studied previously in the functioning of natural or man-made systems. They fall under two headings, but there is no strict division between them:

— Functioning of the ecosphere and ecosystems;

— Evolution and operation of man-made environments.

e) Finally, there are auxiliary courses of a technical nature to teach students how to process or present data. These include statistics, information processing and simulation, semiotics, cartography and modern languages.

Having received this training, students are ready to start the second study cycle leading to a recognised qualification.

Content of second cycle studies (Master's Degree in the Science and Technology of Environmental Management)

The first year is again planned as a common core. It leads to two different certificates taken simultaneously, namely:

— Certificate C 1, in environmental management and protection,

— Certificate C 2, in human ecology.

The content of this common core is intended to provide students with the grounding required by all kinds of environmental managers, while the syllabus for the two certificates corresponds to two complementary aspects of man's relations with his environment. Thus C 1 teaches the principles, means and techniques of man's action on the environment, while C 2 shows how man is affected by his environment.

Syllabus for C 1

C 1 consists of three main sections which disregard traditional disciplines and their dividing lines, viz.

a) General principles of physical management and of the management of resources and activities:

— Problems of political economy raised by the overall management of the environment (policies for energy, resources, transport and population; comparative study of forecasting and planning policies and methods, systems of ownership, land use controls and uses of the environment);

— Management of natural resources (relative and absolute constraint, turnover, principles of recycling, and soil conservation);

b) Management of quality of life, case studies:

— Distribution and balance of activities, housing and accommodation, traffic and infrastructure, leisure;

— Basic techniques of town planning and architecture, civil engineering and hydraulic engineering;

— Consideration of non-quantifiable values: development of cultural and natural assets;

— Analysis and implementation of environmental management projects with plans, models, maps and simulation;

c) Techniques of expression and leadership:

— English

— Group leadership.

Syllabus for C 2

The final objective of all regional and resource planning is man. Every environmental planner must know how the quality of life influences man's physical and mental health, not only through changes in the physical environment (pollution and nuisances), but also through his psycho-somatic reactions to living conditions, conditions of work, housing, travel, mass media, etc. Certificate C 2 consists of two main sections:

a) Psycho-sociology and social medicine:

— Analysis of the effects of working conditions, of accommodation, housing, travel, transport and pollution, on man;

— Influence of activity rates and density of population;

— Social evils;

b) Human physiology and hostile factors:

— Stress;

— Dangers from chemicals;

— Dangers from bacteria.

The second year of the Master's Degree course is composed of elective subjects. It, too, consists of courses leading to two certificates:

a) The course for *Certificate 3* takes up the first six months of the academic year and enables students to be given theoretical instruction relevant to the subject chosen. There are three elective subjects with some teaching common to all three. These are:

— Management, planning and administration of territorial communities in an urban environment;

— Planning and administration of territorial communities in a rural environment;

— Value of natural assets and man's heritage and their importance in daily life.

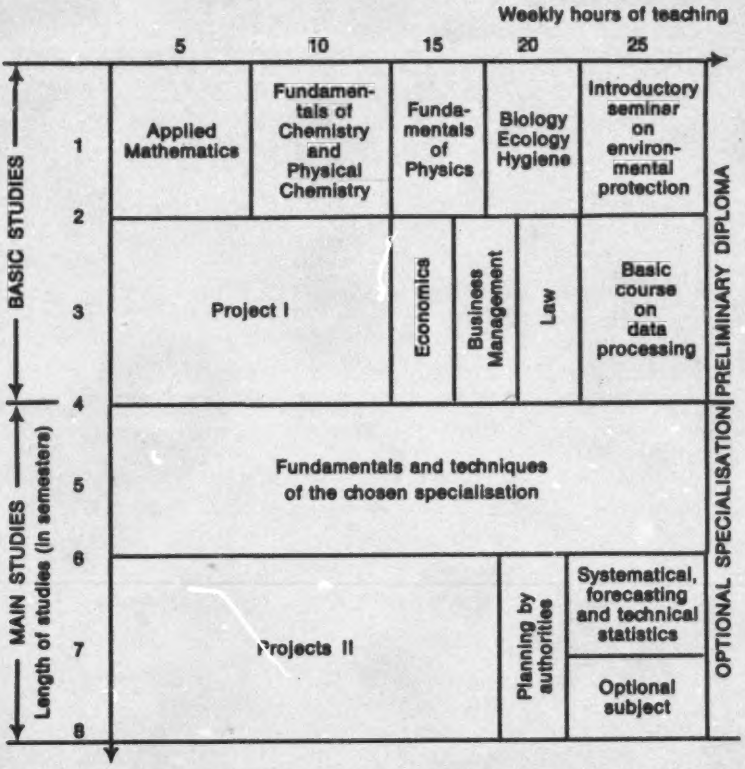
b) *Certificate 4* is built up on a training course lasting form 10 to 15 weeks. This is given in an environmental management institute appropriate to the subject chosen by the student. In order to make the course more profitable to the student, the CESA collaborates with the institute in deciding upon the precise subject on which he will work. At the end of the course the student writes a report describing the conditions in which he has worked, giving a critical account of the study or project in which he has taken part and going more deeply into any aspect he considers particularly important. This report is submitted to a pluridisciplinary jury.

It is our intention that the best of the students who have taken the Master's Degree in the Science and Technology of Environmental Management should be able to complete a fifth year preparing them for an Engineering Degree in the Science and Technology of Environmental Management. During this fifth year, the students would have as their subject a type of environment corresponding to a particular ecosystem: Mediterranean, tropical, humid, mountainous, etc. but this could only be organised with the help of close international co-operation. The student must have the possibility of moving from one teaching institution to another, in order to work in specific types of environment.

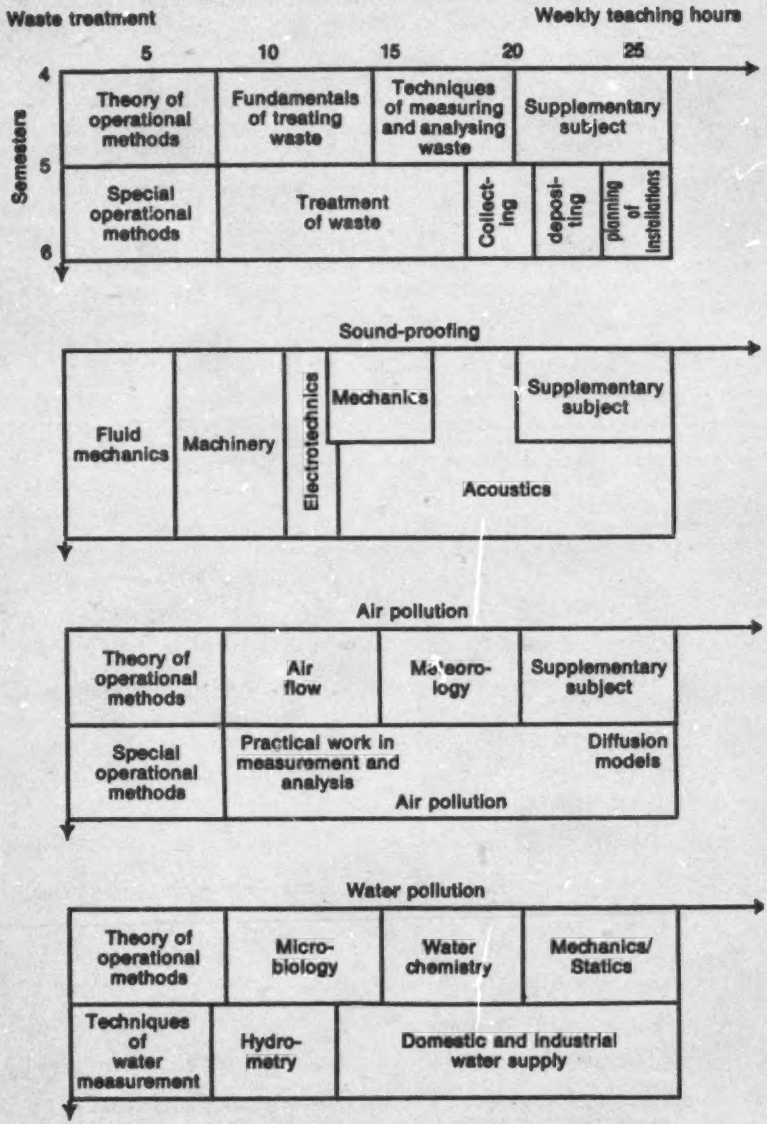
Federal Republic of Germany

Technical University of Berlin (West)

Guidelines for the Study Course on Environment Protection Techniques (Technischer Umweltschutz)



Fundamentals and techniques of the chosen specialisation



ITALY

PRO DEO INTERNATIONAL FREE UNIVERSITY OF SOCIAL STUDIES

Training course on environmental policy

The objective of the Course is not to train professional experts, but rather to provide information and to arouse participants' awareness of environmental issues, focusing chiefly on decision-makers, and it therefore covers a wide range of disciplines. The aim is to call attention to the impossibility and irrationality of any sectorialism in environmental matters. One of the most serious defects of a country's environmental policy lies in jealously separated competencies and the consequent handling of environmental problems in tight compartments with no intercommunication or interrelations. The principal objective of the Course is to show that intervention in one sector may have repercussions in many other sectors, even in those which seem remote.

There are therefore two main aspects of the Course:

a) familiarisation with the main elements of basic ecology in the broader sense of "global ecology": physical, biological and human environmental factors; basic concepts of ecosystem, biosphere and ecosphere; biochemical cycles, dynamic equilibria; natural and man-made landscapes.

b) study of the effects on the environment of the use of natural resources, with special reference to sources of energy, cost-benefit problems, and the possible alternatives open, especially to Italy.

The main items in the Course are as follows:

— Elements of general ecology — Man and environment.

— Energy cycle and biogeochemical cycles — Human intervention and consequent effects.

— Vegetation, Reafforestation. Human settlements and vegetation. Wildlife. Marine equilibria, Parks and nature reserves.

— Soil and soil protection.

— Population, natural resources and environment.

— The town as an artificial ecosystem — Urban congestion.

— Transport and traffic development in towns — The problem of leisure.

— Waste disposal.

— Energy and the environment.

— Air pollution: sources and effects. Pollution and the work environment.

— Water problems. Desalting of seawater and brackish waters. Hydro resources in Italy. Needs and water resources. Water pollution. Pollution of the sea.

— Elements of environmental economics. Integration of the environment objective into national and regional planning. Monitoring the state of the environment.

— The ideology of nature.

— The limits of development.

NETHERLANDS

PROGRAMME OF INTER-FACULTY POST-GRADUATE COURSE ON ENVIRONMENTAL MANAGEMENT,

University of Amsterdam IWG

Syllabi/articles (in total about 2000 pages) will be studied and discussed before the lectures in small groups under trained discussion-leaders will start.

The course stands for 4 months of concentrated study. A test in april '74 is obligatory.

All lectures will be given in the Dutch language.

For students of some faculties participation in an additional part is necessary to obtain validity for the degree courses of their faculty (2 months laboratory — or fieldwork); this regards students in chemistry, biology, physical geography.

PART I: Introductory Part

A closer examination of the main theme of the course.

— 4 days' residential outside Amsterdam.

— Opening address by the chairman.

Exchange of background information and expectations of staff and participants. The students split up in 8 inter-disciplinary discussion-groups of about 15 members each.

— Lecture on "Man and Environment", by social scientist.
Preparation of the discussion in the groups.
Plenary meeting.

— Lecture on "Environmental Management and Awareness" by natural scientist and philosopher.
Preparation of the discussion in the groups.
Plenary meeting.

— Lecture on a case-study "Living in an industrial-urban neighbourhood — A diagnosis of the present man — environment situation", followed by discussion.

Preparation of discussion in the groups.

Plenary meeting.

Explanation of the main theme of the course to assess the identity of the major disciplines involved.

Plenary discussion.

PART II

A: BLOCK A:

Lectures followed by multi-disciplinary discussions.

Week I:

— Principals of the General Systems Theory

— Theoretical Model building (strategies for survival)

— Lecture on and discussions of "The limits to Growth" report for the "Club of Rome".

— Technological thinking, value and limits.

Week II:

ECOLOGY:

a) — general introduction to ecology
— Climate — a component of the Ecosystem
— Plants — a component of the Ecosystem
— Animals — a component of the Ecosystem
— Soil — a component of the Ecosystem

b) — Agricultural methods and application

c) — Social Ecology

d) — Medical welfare and Psycho-ecology

Week III:

ECONOMY:

— Basis facts of Economy
— Economic approach to the environmental problems
— Macro-economic models
— Micro-economic models

EVALUATION

PART II

B: WORKSHOP:

2 days residential outside Amsterdam.

Functional integration of and reflections on the course on environmental management.

Brief introduction to, and preparation of the case studies (Part III b).

PART III

III a) Block B — Lectures followed by multi-disciplinary discussions.

Week IV:

Technolgy:

- — Technology and Environment
- — Pollution and Wastes — use and abuse of the air — water — soil
- — Toxicology in Food, through nuclear radiation, etc.
- — Energy and Matter — a delicate balance.

Week V:

Social Sciences:

- — demography/population growth
- — historical view on the industrial society
- — space planning — Urban growth
- — Law and environment
- — Public Administration and Environment

Week VI:

Values and norms:

- — political science and environmental policy
- — prosperity and wellbeing
- — the responsibility problem

EVALUATION OF THE COURSE

III b) Case-studies by interfaculty groups of students. The subjects will be chosen by mutual arrangement between staff and students.

IV: Seminar on the habitual problems of the South-Western Area of the Netherlands.

Programme will be published in due time.

TECHNICAL UNIVERSITY OF DELFT

"Inleiding tot de Milieukunde" (A:2)

— Evaluatie van de menselijke behoefte — welvaart/welzijn
(Dr. D. Hillenius)

— Ecologie: systeëmtheorie en kringlopen
(C. G. van Leeuwen, RIN, Leersum)

— Vaste afvalstoffen
(Ir. T. Teeuwen, SVA, Amersfoort)

— Water: gebruik en beheer
(Prof. Ir. L. Huisman, TH, Delft)

— Lucht: algemene aspekten (45 min.)
(Ir. L. J. Brasser, TNO, Delft)
medische aspekten (45 min.)
(P. E. Joosting, arts, TNO, Delft)

— Geluid en verkeer
(Ir. W. A. Oosting, TNO-TPD, Delft)

— Economische aspekten
(Prof. Drs. E. H. van der Poll, TH, Delft)

— Toekomst en internationale aspekten
(Prof. Ir. H. Wiggerts, TH, Delft)

UNIVERSITY OF LEIDEN

DE REALISERING VAN NATIONALE LANDSCHAPSPARKEN IN NEDERLAND

Afdeling Milieubiologie van het Zoölogisch Laboratorium (Dr. H. A. Udo de Haes, W. J. ter Keurs, A. Majolée)

Afdeling Beleidsadvisering van het Sociologisch Instituut (Drs. J. J. Onland)

De cursus wordt georganiseerd in het kader van de Commissie Onderlinge Regionale Samenwerking tussen de Universiteiten van Leiden en Rotterdam en de Technische Hogeschool van Delft.

1. Defensieve Natuurbescherming en werkelijk Milieubeheer.
2. Landschappen in Nederland.
3. Industriële landbouw en landschapsparken.
4. Wonen op het platteland.
5. Landschapsparken als proeftuin voor nieuwe landbouwmethoden.
6. Openluchtrecreatie en Landschapsparken.

7. Het autoverkeer en de resten van het landschap.
8. Economische groei en toenemend ruimtebeslag.
9. Natuurbeheer én beheer en ontwikkeling van het landschap.
10. Vragen Nationale Landschapsparken om andere wetten?
11. Waterland tussen Amsterdam - Noord, Groot - Purmerend en de Markerwaard.
12. Keerzijden van de presentatie en de realisering van Nationale Landschapsparken.

UNIVERSITY OF LEIDEN (cont)

RUIMTELIJKE EN SOCIALE ONTWIKKELINGEN IN HET GEBIED LEIDEN - DEN HAAG - DELFT

Alternatieven in wonen, recreatie en vervoer, bezien vanuit het oogpunt van milieubeheer.

Landschapsontwikkeling en cultuurhistorie.

Demografische ontwikkelingen.

Ruimtelijke processen en het autoverkeer.

De beheersing van ruimtelijke ontwikkelingsprocessen door de overheid.

Sociaal-geneeskundige consequenties van de huidige ontwikkelingen.

Het doen van een politieke keuze.

De implicaties van alternatieven in woningbouw.

Ontwikkelingen en alternatieven in recreatie.

Alternatieven in vervoer.

Economische benadering van het vervoer.

Bestuurlijke aspecten bij realiseren van alternatieven.

Two examples of the Leiden programme courses are given to illustrate the approach of taking a concrete problem as the focus of an overview course.

TECHNICAL UNIVERSITY OF TWENTE AT ENSCHEDE

Programme "Environmental Engineering" in the Chemical Engineering Department.

The graduate programme is based on a Bachelor's Degree in chemical engineering and emphasises the systematic approach of environmental problems.

Three basic disciplines in the programme are

— environmental biology and chemistry

— optimisation techniques and statistics

— systems analysis and model building techniques.

A representative curriculum is:

Mathematics:

Operation Research
Simulation
Applied Statistics

Chemistry/Biology:

Environmental Chemistry
Microbiology-biochemistry
Ecology/Toxicology

Technology:

Chemical Reaction Engineering
Processdynamics
Sanitary/Environmental Engineering
Systems Analysis in Water Quality Management

Social Sciences/Economics:

Capital Budgeting
Economy
Regional Planning
Law

A master's thesis is required, involving one year of specialised study focusing on a (preferably) existing environmental problem.

AGRICULTURAL UNIVERSITY OF WAGENINGEN

Programme in environmental sciences.

Propaedeutical study (2 semesters)

mathematics
physics
physical and analytical chemistry
organic chemistry
biology
political economy

Candidate's study part A (2 semesters)

methodology
mathematical statistics
colloid chemistry
organic chemistry
cell-physiology
microbiology
physiology
physics (measurements)
physics (transfer phenomena)
meteorology and climatology
ecology

Candidate's study part B (2 semesters)

compulsory subjects

a) chemical-microbiological differentiation
microbiology
organic chemistry
colloid chemistry

b) hygienic-biological differentiation
microbiology
town and country planning
nature conservation and management
law
extension education

c) technological differentiation
colloid chemistry
technology
mechanics
civil-engineering
industrial economics

d) soil pollution control differentiation
soil pollution control
soil physics
microbiology
colloid chemistry

optional subjects e.g.

biochemistry
physical chemistry
mathematics

biochemistry
virology
watermanagement

law
watermanagement
physics
mathematics
hydraulics

town and country planning
mathematics
watermanagement
nature conservation and management

Practical period (1 semester)

A practical period of half a year is spent at two or three official bodies in the field of environmental health.

Doctoral study (3 semesters)

For 2-3 subjects an experimental and/or literature research is conducted. Main subjects are waterpurification, air pollution control, soil and groundwater pollution and nature conservation and management.

NORWAY

UNIVERSITY OF OSLO

1. *Overview course "Man and Nature".*

The course is divided into three parts: 1. introduction to ecology and ecological concepts; 2. "ecophilosophy" in which the relation man-nature is studied in a philosophical and historical perspective; 3. historical study of methods used to resolve the conflicts man-environment.

The course lasts for 1 semester (2 hours of lecture and 2 hours of seminar per week).

2. *1semester environment seminar programme.*

I. Ecological fundamentals.

II. Human ecology.

III. Environmental deterioration.

IV. Problem analysis and solutions.

V. Project work.

I. The ecosystem, ecological successions, evolution, population ecology, food chains, energy flow, biogeochemical cycles.

II. Primate ecology — from protohominide to man, biological and non-biological resources, energy, man and nature as seen by different cultures, work environment, social organisation and built environment. Uses of the science of human ecology in society.

III. Typical ecosystems — normal state and common types of disturbances, recipient capacity; definitions of pollution; the health concept, environmental factors and health, global environmental problems; long range perspectives; national and local problems; case studies.

IV. Quality of life and social indicators, social economic analysis and solution to environmental problems; existing and possible new laws; public and private administration and planning; strategies for change based on the individual's needs; technological change; population control; social change and ecopolitical pressure groups.

This programme is open to students from all faculties with a minimum of 3 years of previous studies. Organised teaching is about 15 hours per week. Participation in group work is obligatory. The groups will be self-governing.

Entry to the programme is restricted. No criteria for selection are indicated but stress will be put on getting a variety of sudents from many faculties into the programme.

UNIVERSITY OF TRONDHEIM

1. Overview course given by the Institute of Technology. (A:2)

   Themes: general ecology; ecology and philosophy; air pollution; water pollution; environmental poisons; noise; industrial safety; planning and natural resource management; relationship economy - industry - environment; environment protection legislation.

2. *One semester programme.* (A:4)

Introduction

Social sciences: demography, regional development, opinion making, economic policy, market economies and planned economies, economic growth. Introduction to planning theory and the historical development of physical planning and natural resources management. Economic models in planning. Planning legislation.

Biological sciences: cell biology, metabolic effects of poisons, Anatomical and physiological adaptations of organisms. Genetic variation. Population ecology, general ecology. The ecosystems of Norway - production and recipient capacity. Environmental change - pollution, landscape alteration. Human ecology.

Technology: Norwegian industry - location and economic structure. Non-biological resources distribution and abundance. Tecnological perspectives. Nuclear energy. Solid waste problems. Effluent water from industry and municipalities. Industrial air pollution problems. Air pollution from cars. Noise.

Specialised courses. These are chosen to deepen the student's knowledge in previous field of education or training. They contain 60-80 hours of lectures and 100-120 hours of lab. work, seminar, project work etc. = options are available: air pollution control; water pollution control; biological resources; environmental hygiene; town and regional planning; regional sociology.

Common activities. The various student groups from specialised courses are brought together in project work, seminars and excursions.

SWEDEN

UNIVERSITY AND INSTITUTE OF TECHNOLOGY, LUND

1. *ENVIRONMENTAL STUDIES, 10 POINTS PROGRAMME* (A:2)

1. *Introduction* . . . . . 2 points
   Ecology, environmental hygiene, genetics, pesticides, the work environment
2. *Water pollution problems* . . . . . 2 points
   Water resources, water pollution and control, lake restoration
3. *Air pollution and noise problems* . . . . . 2 points
   Air chemistry and meteorology, air pollution and control, noise problems
4. *Waste problems, radiation problems, conservation* . . . . . 2 points
   The solid waste problem, natural resource management. Radiation problems
5. *Society and environment* . . . . . 2 points
   Legislation, administration, physical planning, economics, international co-operation

1 point equals one week of full time studies. The 10 point programme is however run in evening classes over one semester.

GROUP WORK is obligatory and is done in a group of mixed background.

The programme is open not only to university students but also to persons with no previous academic education. (A minimum requirement of 25 years of age and 5 years of vocational experience is in force.)

2. *ENVIRONMENTAL STUDIES, 40 POINTS PROGRAMME*

(A:4, B:II + B:III)

INTRODUCTORY ALTERNATIVES (15 points)

1. Chemistry . . . . . 2 points
2. Physiology and medical introduction . . . . . 5 points
3. Earth science . . . . . 2 points
4. Ecology . . . . . 6 points
5. Economic resource allocation . . . . . 5 points
6. Physical and regional resource planning . . . . . 5 points
7. Administration . . . . . 2 or 3 points
8. Bio-statistical methods . . . . . 5 points
9. Systems ecology . . . . . 5 points

OBLIGATORY

10. Environmental hygiene . . . . . 5 points

    The human environment, radiation, biocides, solid waste, nuisances, the work environment

11. Conservation . . . . . 5 points

    Soil science, ecosystem management, land use, agriculture, forestry, wild life, landscape planning, conservation

12. Water pollution control . . . . . 5 points

    Water resources, pollution, effects of pollution, pollution control technology, fishing, lake restoration

13. Air pollution control and noise abatement. The interrelationships of pollutants and pollution . . . . . 5 points

    Air pollution effects, control technology, economics, planning and legislation. Noise abatement technology - economics, planning, legislation

    The interrelationship between pollutants and media: air- soil and water. The biosphere.

14. Society and environment . . . . . 5 points

    Legislation, administration, economics, national physical planning, environmental politics - relationship to other sectors of society, international co-operation. (Part of this course is given as an introduction to the entire study programme.)

This programme is full time (= 40 points) for one year.

UNIVERSITY OF ASTON IN BIRMINGHAM

B.Sc (sandwich) course in environmental health. (B:II)

FIRST YEAR	**Biology**
	Chemistry
	Mathematics
	Physics
	Construction
	Applied Science
	Surveying
	Law and Practice
	General Studies
SECOND YEAR	**Biology**
	Chemistry
	Physics
	Statistical Method
	Construction
	Applied Science
	Building Services
	Public Services
	Law and Practice
	Food Hygiene and Inspection
	General Studies
THIRD YEAR	**Biology**
	Physics
	Applied Science
	Building Services
	Specifications, Quantities and Estimates
	Law and Practice
	Food Hygiene and Inspection
	Air Pollution Control
	General Studies
FOURTH YEAR	**Health Physics**
	Construction
	Law and Practice
	Food Hygiene and Inspection
	Air Pollution Control
	Project Study

UNIVERSITY OF EDINBURGH

Department of Forestry and Natural Resources.

B Sc Degree Course in Ecological Science.

COURSE OUTLINE

Some flexibility may be allowed to meet particular needs but the course normally follows the following pattern:

First Year *Biology 1, Chemistry 1B, Introductory Physics with Mathematics 1.*

Second Year *Ecology 2h.* Ecology of renewable resource systems; structure, function and dynamics of plant/animal populations, communities and systems and man's effect on them.

Applied Biology 2h. Factors influencing the production and utilisation by man of essential food materials and certain other natural products.

Resource Management 2h. Survey; photo-interpretation, photogrammetry; mensuration; statistics.

Soil Science 3h. Soil as a natural phenomenon and as a medium for plant growth; soil types; physical and chemical properties and their effect on plant growth.

Third Year *Ecology 3.* Terrestial and aquatic biological production systems. *Climate and Water Resources 3h.* Introduction to climatology, hydrology and water management as components of the physical environment; their application to land-based activities.

Resource Management 3h. The economics of resource management; principles of rural land planning and environmental management.

Fourth Year Honours subjects - *three courses to be chosen.* Honours degree.

HONOURS SUBJECTS

The following is a list of courses which are currently available. These may be changed from time to time.

Applied Climatology and Micrometeorology. The application of climatological information and micrometeorological theory to resource management and land-use problems; methodology of climatic analysis and data interpretation.

Forest Management. The development of forest management and present pratice; management plans.

Freshwater Fisheries Management. Economic importance; effects of man's influence and methods of control; legislation; habitat management; propagation and population control; fish farming; future developments.

Land Use Economics. Market influences; project and public investment evaluation; cost-benefit analysis; operational research; land capability studies; macro-economic evaluation of land development options.

Land Use Planning. History; landscape; recreation; planning techniques; case studies; rural land planning.

Pathological Population Ecology. Impact of microbes on ecosystems; origin of plant and animal pathogens; economic importance; controls.

Plant Ecology. Relationships between plants and their physical and biotic surroundings; plant performance; experimental approach to the study of plant communities.

Silviculture. Tree-site relationships; site potential and amendment; soil development; competition increment distribution; thinning and spacing effects; dominance; regeneration felling patterns; ecotypic variation; provenance and tree improvement programmes.

Soil Science (Agriculture Department). Pedology; soil biology, chemistry and physics; land use capability classification.

Water Management. Appraisal of water resources and their development potential; assessment of demands for use and control of water resources; management objectives and means to achieve them.

Wildlife Management. Dynamics of populations; regulatory processes; effect of shooting policies and natural mortality on structure; manipulation of population and habitat; ecology of introductions; research management of game reserves.

KING'S COLLEGE. UNIVERSITY OF LONDON

School of Human Environmental Studies.

FIRST YEAR (All courses compulsory)

1. Foundation Course - 1½ Course Unit
   Introduction and general Framework
   Part A - Basic principles of ecology and evolution
   Part B - Historical approach to human ecology
   Part C - Regional and habitat approaches to human ecology and its practical problems.
2. Data Analysis - ½ Course Unit
3. Maintenance of the internal environment of man - ½ Course Unit
4. Environmental geology - ½ Course Unit
5. Environmental engineering - ½ Course Unit

SECOND YEAR

A choice of three and a half course units selected from the following courses. Some are still in the planning stage and therefore provisional; others are given by title only.

1. Population and resources - ½ Course Unit (Compulsory)
2. Economy of the environment ½ Course Unit (Compulsory)
3. Man's response to the external environment - ½ Course Unit (Compulsory)
4. Land Utilisation analysis - ½ Course Unit
5. Pollution - ½ Course Unit
6. Plant ecophysiology - ½ Course Unit
7. Soils - ½ Course Unit
8. Energy - ½ Course Unit
9. Renewable biological resources - ½ Course Unit
10. The built environment - ½ Course Unit

THIRD YEAR

The third year courses are all directed towards the solution of particular environmental problems and build upon the broad education of the first two years, so as to equip students for a variety of environmental oriented careers. Students will have a choice of three course units selected from the following titles:

1. The sea - 1 Course Unit
2. Water resources - 1 Course Unit
3. Ecology of disease - 1 Course Unit
4. Landspace and biological conservation - 1 Course Unit
5. Legal aspects of the environment - 1 Course Unit
6. An environmental project under supervision - 1 Course Unit
7. Seminar - ½ Course Unit

Seminar (½ Course Unit)

A practical course in the preparation of environmental cases for oral presentation in various types of situation. Techniques of public speaking: of participation in discussions. The art of chairmanship. Committee procedure. The use of illustrative material. The subject selected will include some topics that come into the news during the course, in order to give practice in alertness and flexibility in tackling new problems, and in speed in researching urgent environmental issues.

UNIVERSITY COLLEGE. UNIVERSITY OF LONDON

Postgraduate Course in Conservation.

The course provides a knowledge of the structure and functioning of physical, biological and social systems and applies this knowledge to their conservation and management for stability and sustained use.

The course is taught under 6 main headings.

1. PHYSICAL SYSTEMS

Geology of the British Isle; basic principles of geomorphology; management of geomorphological systems including the alluvial landscape, soils, streams, estuaries and coasts; climatology, local climate and atmospheric conditions, behaviour of atmospheric pollutants; hydrology, management of water quantity and quality.

2. BIOLOGICAL SYSTEMS

The taxonomic structure of the plant and animal kingdoms; structure and function of biological systems, distribution and abundance of plants and animals, nutrient cycles and energy flow in ecosystems; measurement of primary and secondary production; management of aquatic, terrestrial and transitional habitats, selection and management of nature reserves. Management of plant and animal populations.

3. SOCIAL SYSTEMS

Land-use competition in Britain, forestry, agriculture, recreation, urbanisation, economic concepts; social organisation; landscape evaluation, restoration of derelict land. Conservation agencies, conservation education. Planning for recreation, amenity and conservation.

4. ECOLOGICAL TECHNIQUES AND THEIR APPLICATION

Methods of survey; air photographs, field survey methods, mapping of land forms and soils, vegetational and faunal sampling and analysis, land-use mapping, historical and current sources of information. Ecological statistics, data collection and analysis.

5. CASE STUDY SEMINARS

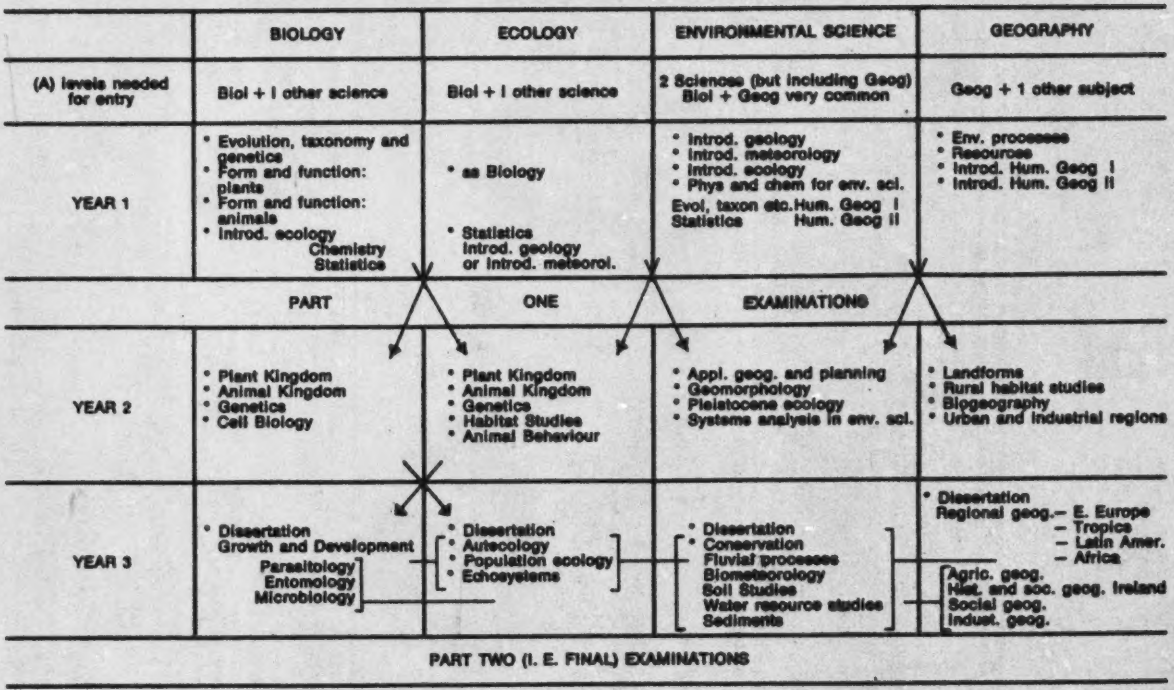
The above syllabus will be supported by seminars on the application of conservation principles in land survey, planning and management.

6. FIELD WORK

The components of the course are supported and integrated by means of field work. The first month of the course involves field work in various parts of Britain with assistance from Nature Conservancy personnel, visits to Nature Conservancy Research Stations, Nature Reserves (Forestry Commission areas), Countryside and National parks and other areas and organisations representative of rural-land use. During the first and second terms several visits, for field and laboratory work, are made to sites and research stations, including the Nature Conservancy Experimental Station at Monks Wood, Huntingdon. Further periods of field work during April to August consist mainly of a group project on some selected topic and the preparation of individual reports under general supervision from the staff of the course.

RESEARCH FACILITIES

Facilities for research for a higher degree at the conclusion of the course may be available in the College for students of outstanding ability.



• See details in the following note.

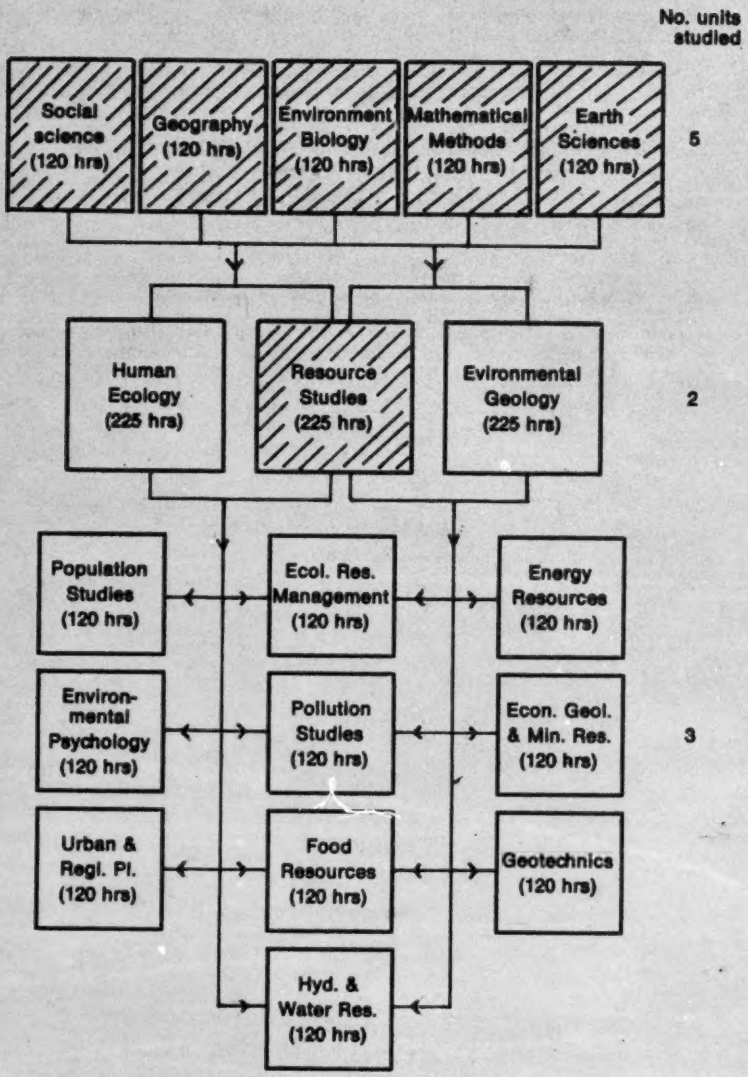
NOTE

1. All students take 6 units per year for 3 years (18 units in all). It is possible to take some units (but not many) from another year.
2. Units marked are compulsory components of the programme in which they are shown.
3. Change from one programme to the adjacent one is often possible (✈), or exceptionally so (✈) but may require careful of optional units.
4. It is possible to take a few way-out optional units from other Schools of the University, or other parts of one's own School, especially in years 1 and 2.
5. In Year 3 it is usually possible to include some units from another programme, rather than to change the programme.
6. Most units, but by no means all, have specified pre-requisites. Progression, in this sense, reduces flexibility.
7. Each programme can be taken concurrently with education over 4 years, usually involving 15 units from the programme as listed, and 9 education units, giving a subject degree and a teaching qualification.
8. Related degree programmes, using many of the units listed here but administered by other Schools of the University, include Human Ecology, History of Resource Management and Biological Chemistry.

PLYMOUTH POLYTECHNIC

School of environmental Sciences
B Sc (honours) in Environmental Sciences.

Omitting interdisciplinary seminars.
The shaded units are followed by all students.



PART I

There are 4 units in Part I, all of which are compulsory

Geography

Environmental Biology

Mathematical Methods

Earth Science

9.0 GEOGRAPHY (120 hrs)

9.1 Physical

9.1.1 Evolution and Differentiation

9.2 Human

9.2.1 Evolution and Differentiation

9.3 Cartography

10.0 ENVIRONMENTAL BIOLOGY (120 hrs)

10.1 Biological Organisation

10.1.1 Cells and Organisms

10.2 Environment: Sensitivity and Response

10.3 Practical

11.0 MATHEMATICAL METHODS (120 hrs)

11.1 Algebra

11.2 Calculus

11.3 Numerical Methods

11.4 Computing

11.5 Statistics

11.6 Practical Work

12.0 EARTH SCIENCE (120 hrs)

12.1 Introduction to Earth Science

12.2 The Earth

12.3 Environments of mineral and rock formation (different minerals develop under different circumstances)

12.4 Rock Deformation and Displacement

12.5 The Stratigraphical Record

12.6 Applied and Economic Geology

12.7 Practical Work

13.0 PART I INTERDISCIPLINARY SEMINAR PROGRAMME
(15 x 2 hrs = 30 hrs)

13.1 Concept of the Environment

13.2 Origin of life

13.3 Survival of the Fittest

13.4 Ecological Niches

13.5 Evolution, chance or necessity

13.6 Populations

13.7 Distribution of Life

13.8 Energy Sources and the Biosphere

13.9 Domestication of plants and animals

13.10 The Neolithic Revolution

13.11 Cultural Diffusion

13.12 Environmental Challenge and Man's Response

13.13 Scientific Method

13.14 The "finite earth" concept

13.15 Civilisation

PART II

In this year, all students take the study area,
RESOURCE STUDIES
together with either
HUMAN ECOLOGY or
ENVIRONMENTAL GEOLOGY

14.0 HUMAN ECOLOGY (225 hrs)

14.1 The Biological Context (25 hrs)

Aim: To provide the student with a working behavioural background stressing that man's physiology and behaviour result from his primate phylogeny and natural selection. This should prevent the student making unthinking generalizations from the behaviour of other animals, or overconfident assertions of man's rationality.

14.2 The Social Context (75 hrs)

Aim: To give the student a basis for understanding the interaction between the individual, the social structure and the environment.

14.3 The Political Context (75 hrs)

Aim: To consider politics as an essential social activity which seeks to define society's needs, formulate its objectives and to fulfil those objectives through the processes of government. Specific reference will be made to the interaction between social, political and economic institutions and the significance which this poses for environmental analysis.

The emphasis will be chiefly though not exclusively on British Society.

14.4 The Agencies of Environmental Change (50 hrs)

14.4.1 Technical Processes

15.0 RESOURCE STUDIES (225 hrs)

Resource studies aim to provide the student with skills for resources appraisal and to introduce concepts of environmental management.

15.1 The Economics of Resource Allocation (75 hrs)

Aim: To introduce the student to the problems of resource allocation and welfare analysis. Considerable use will be made of the mathematical methods developed in Part I.

15.2 Resource Appraisal (150 hrs)

15.2.1 Resource Pressure (30 hrs)

15.2.2 Mineral and Energy Resource Appraisal (10 hrs)

15.2.3 Soil as Resource (10 hrs)

15.2.4 Biotic Resources (40 hrs)

15.2.5 Hydrology and Water Resources (20 hrs)

15.2.6 Human, Urban and Recreational Resources (10 hrs)

15.2.7 Environmental Economics (30 hrs)

16.0 ENVIRONMENTAL GEOLOGY (225 hrs)

The aims of this course are i) to show the interplay to the more important geological processes which shape the earth and influence the formation and distribution of useful geological materials and ii) to provide ability in the methods of obtaining new basic information as well as critically assessing data and interpretations reported by others.

16.1 The formation, occurrence, and properties of useful geological materials

16.2 Sedimentary Environments

16.3 Structural Geology and Gectectonics

16.4 Geological Investigation

17.0 INTERDISCIPLINARY SEMINARS (30 hrs)

17.1 *All Students* attend.

17.1.1 Science in Society

17.1.2 Concept of Conservation

17.1.3 The Shibboleth of Economic Growth

17.2 *Students reading Human Ecology and Resource Studies* attend

17.2.1 Fecundity and Prosperity

17.2.2 Nutrition and Economic Development

17.2.3 Invasion and Succession

17.2.4 The factory system and its consequences

17.2.5 Peasant and proletarian attitudes to the Environment

17.2.6 The Industrial State

17.2.7 Governments and Resources

17.2.8 Land Ownership in Britain

17.2.9 Access to the Countryside

17.2.10 Consumer Behaviour

17.2.11 Leisure

17.2.12 The Politics of Over Exploitation

17.3 *Students reading Environmental Geology & Resource Studies* attend

17.3.1 Economic margins of resources

17.3.2 Scale of Exploitation of Resources

17.3.3 Pricing of Resources

17.3.4 Energy use and misuse

17.3.5 The Limits of Soil Fertility

17.3.6 Water as a Commodity

17.3.7 The Vulnerability of Aquatic Systems

17.3.8 Influence of Ownership on Resource Use

17.3.9 Land loss and gain

17.3.10 Industrialisation of Agriculture

17.3.11 Advanced Technology and Primitive Agriculture

17.3.12 Affluence and Resources

PART II B

In the final year, each student opts for 3 topics. These may be chosen to allow him to study a narrow field in depth (e.g.: Geotechnics, Economic Geology and Mineral Resources, Applied

Palaeoenvironmental Analysis), or to maintain a broad approach to the subject (e.g.: Population Studies, Pollution Studies, Food Resources). The topics available and their prerequisites are:

18.0	Population Studies	prerequisite is study of Human Ecology in year 2.
19.0	Human Ethology	
20.0	Urban and Regional Planning	
21.0	Ecological Resource Management	prerequisite is Resource Studies in year 2.
22.0	Pollution Studies	
23.0	Food Resources	
24.0	Hydrology and Water Resources	
25.0	Applied Palaeoenvironmental Analysis	prerequisite is study of Environmental Geology in year 2.
26.0	Economic Geology and Mineral Resources	
27.0	Geotechnics	

In addition, each student must complete a project, which may be field, laboratory, library or computer based.

18.0 POPULATION STUDIES (120 hrs)

The aim of this course will be to give the student an understanding of the major factors influencing population size, distribution and composition. The economic consequences of population growth and the relationship between demographic processess and the environment will be explored.

18.1 Determinants of Population Size

18.2 Patterns of Population Composition

18.3 Case Studies of Population History and Policy

18.4 Population Distribution

18.5 Migration

18.6 Population Growth and Economic Development

18.7 Population Theory

18.8 The Population Crisis - Population Control and Future Prospects

18.9 Techniques and Measures

19.0 HUMAN ETHOLOGY (120 hrs)

Aim: To give the student an appreciation of the organised developments of simple and complex response patterns in different environments and to develop an understanding of the possible mechanisms and processes underlying man's relationships with other men and with the artifacts of his own technology.

19.1 General Ethology

19.2 Human Ethology

20.0 URBAN AND REGIONAL PLANNING (120 hrs)

This course is concerned to provide students with an appreciation of the major problems and techniques of urban and regional planning. The course will consider the policies which have been adopted to deal with planning problems, and the impact which these policies have had on the environment. The emphasis will be primarily, but not exclusively, on the British situation.

20.1 Introduction

20.2 Urban Planning

20.3 Regional Planning

20.4 Techniques in Urban and Regional Planning

21.0 ECOLOGICAL RESOURCE MANAGEMENT AND CONSERVATION (120 hrs)

Aim: This course will provide practical experience in field work together with computer simulation of ecological systems rather than an appreciation of the historical development of management and conservation practice. The systems approach, introduces in the second year, will be used throughout, and this option is likely to appeal to students with a mathematical bent.

21.1 Defining objectives

21.2 Investigating the ecosystem

21.3 Analysis and modelling

21.4 Practical Work

22.0 POLLUTION STUDIES (120 hrs)

This course aims to provide insight into the complexity and interdisciplinary nature of pollution, and the need for liaison between research, technical and administrative bodies.

22.1 Review of causes and effects

22.2 Pollution as an interdisciplinary problem

22.3 Economics and cost analysis

22.4 Legislation

22.5 Control

22.6 Practical Work

23.0 FOOD RESOURCES (120 hrs)

This option is concerned to examine, firstly the sources of food and their limitations, and secondly, the management of food resources on a local and national scale. Finally, global implications and possibilities will be discussed.

23.1 Agricultural Resources

23.2 "Fish" Resources

23.3 "Laboratory Foods"

23.4 Processing

23.5 Tastes

23.6 Marketing and Distribution

23.7 Nutrition

23.8 World Food Supply

24.0 HYDROLOGY AND WATER RESOURCES (120 hrs)

The aim of this course is to present an integrated study of hydrology and water resources. An attempt will be made to analyse the physical occurrence and natural variability of water and its relationships to the social environment and the increasing demands made upon this most fundamental resource.

24.1 Surface Water Hydrology

24.2 Ground Water Hydrology

24.3 Evaluation of Water Resources

25.0 APPLIED PALAEOENVIRONMENTAL ANALYSIS (120 hrs)

This course will be based, and expand, upon the introductory courses in the Earth (12.2) and the subsequent introduction to Sedimentation and Palaeoenvironments (16.2). The aim is to show how a basic understanding of the study of palaeoecology and palaeoenvironments can be applied to the study of mineral and other resources. Several categories of earth resources are formed and/or distributed and/or concentrated by the agencies involved in the formation of any particular combination of environments. The recognition of these diagnostic environments is important to our development and exploitation of present and future resource requirements. The recognition of the limitations imposed on the formation of such environments enables the delimitation of regions of future potential. Throughout the course examples of particular interest will be used to demonstrate this palaeoenvironmental approach. The relative emphasis on the topics covered (e.g.: oilfields, gasfields, evaporites, water, supplies, placer deposits, clays, sands, aggregates, etc.) in any year will vary as new evidence becomes available, or as the trends of the day demand.

25.1 The Nature and Classification of Environments

25.2 Sedimentology

25.3 Palaeoecology

25.4 Applied Palaeontology

25.5 Palaeogeography and Palaeoenvironments through time

25.6 Practical Work

26.0 ECONOMIC GEOLOGY AND MINERAL RESOURCES (120 hrs)

26.1 The useful minerals and their deposits

26.2 Exploration and evaluation

26.3 Extraction and processing

26.4 Legislation

26.5 Economics of mineral extractive industries

26.6 Mineral extraction and the Environment

26.7 Mining geology reports

26.8 Mineral Resources

26.9 Practical Work

27.0 GEOTECHNICS (120 hrs)

The course aims at giving an appreciation of the properties and variability of the subsurface material and their relation to practical and environmental applications.

27.1 The properties of soils and rocks

27.2 Geotechnical and geological considerations in land use and construction

27.3 The Role of Geotechnical and Geological Information in Planning

28.0 INTERDISCIPLINARY SEMINARS (10 x 2 hrs = 20 hrs)

28.1 Construction and Conservation

28.2 Consumable Waste

28.3 Who pays for Pollution Control?

28.4 Mental Health and Environment

28.5 Urban Crisis

28.6 Is there an Optimum World Population?

28.7 Club of Rome Report

28.8 Ideology, Power and Science

28.9 Application of Science

28.10 Environmental Science and education

29.0 PROJECT WORK (90 hrs)

29.1 Social Segregation in Urban Areas

29.2 An investigation of stereotypes and person perception

29.3 Agriculture and amenity on Dartmoor

29.4 The optimum sampling regime for a mussel bed

29.5 Dereliction as an environmental problem; the nature and significance of reclamation and recolonisation

29.6 An investigation of trace elements in Agricultural and Horticultural produce of the Tamar Valley

29.7 Variations in sediments supply from the Narrator Brook, Dartmoor, to Burrator Reservoir.

29.8 Cenomanian Sands of S. E. Devon

29.9 The distribution of lead, zinc, copper and iron in metalliferous mine tip material in the Mary Tavy area

29.10 Investigation of Depth to Bedrock on a Small Building Site

29.11 The influence of changing upland farming practices on soil structure and composition

29.12 The effect of estuarine environmental factors on the amphipod population

APPENDIX

The following final year subjects are clearly within the philosophy of this course and the competence of the staff. However, to offer them at this stage would strain the resources available to the Department. As further space, staff and equipment become available, however, we wish to add these subjects to the options available in the final year.

30.0 ESTUARINE STUDIES (120 hrs)
Prerequisite — Environmental Geology

30.1 Physical features of Estuaries

30.2 Estuarine Biology

30.3 Sedimentary processes in estuaries

30.4 Applications

31.0 SOIL SCIENCE (120 hrs)
Prequisite - Resource Studies

31.1 Soil Structure

31.2 Soil Atmosphere

31.3 Soil Water

31.4 Soil Temperature

31.5 Soil formation

31.6 Chemical properties of soil

31.7 Soil organic matter

31.8 Soil Classification

31.9 Mapping

31.10 Soil Ecology

31.11 Soil Erosion

31.12 Soil Conservation and Management

31.13 Agricultural potential of soils

UNIVERSITY OF SOUTHAMPTON

Department of Extra Mural Studies.

Content of the Course

Year 1 *The nature of the Environment* - a Study of the Bio- or Ecosphere involving relevant aspects of Earth- and Biological Sciences: natural materials, energy, major natural processes, organisms and communities, interrelationships of all these.

Year 2 *The impact of Man: effects and pressures on the Environment* involving trends, problems and perspectives in world population, in the exploitation of renewable and nonrenewable resources including water, in pollution and waste disposal, in conservation and management of resources, habitats and organisms, and in planning and the determination of priorities.

During the residential week, a study of these aspects in a different area of Great Britain to our own - South Wales.

Year 3 The content of this year is two-fold:

(i) *Environmental issues and Problems in our own area of Central Southern England* done by supervised individual project work, and

(ii) *Some global issues* discussed in lecture and seminar meetings, including environmental problems and policies in other parts of the world, the feasibility or otherwise, and implications, of alternative (including no-growth) economic systems and of population control, and repercussions of environmental alterations on human health and society.

Some modifications of content and sequence are envisaged for course III, as follows: -

Year 1 Some consideration of the appearance of man on the Earth and his environmental impact in pre-industrial periods and societies (in addition to the study of the Ecosphere).

Year 2 Some consideration of the causes and pressures of industrialisation, followed by the environmental impact of industrial societies (as before) and a discussion of technology, economics and the feasibility of introducing ecologically more acceptable methods.

Year 3 Comparisons between "developed" and "developing" world, between different existing and potential alternative economic systems; human population trends and control; and planning, management.

The three years of the Course have hitherto been arranged as follows,

Year I:	30 weekly evening lecture meetings:	60 hours
	2 weekend day field meetings:	16 hours
	1 residential weekend session:	20 hours
	Total	96 hours
	Estimate of private study time put in by each student during this year (based on a survey made on this matter)	115 hours
	Total time involved is thus an average of per week for 30 weeks.	7 hours
Year II:	24 weekly evening lecture meetings:	48 hours
	6 evening seminar meetings:	12 hours
	6 weekend day practical and field work sessions:	48 hours
	1 residential week session of 6½ days working 10 hours per day:	65 hours
	Total	173 hours
	Estimate of private study time (arrived at as for Year I)	201 hours
	Total time involved is thus an average of 12 hours per week for 31 weeks (including the residential session)	
Year III:	24 weekly evening lectures, Tutorial and discussion meetings	48 hours
	Estimate of private study time including project work (arrived at as for Year I)	363 hours
	Total time involved is thus an average of per week for 30 weeks.	14 hours

This basic structure is likely to remain substantially unchanged for Course III although some modifications in detail may be made.

UNIVERSITY OF SALFORD

Environmental Resources Course. Central Option

The syllabus for this Course deals with a wide range of environmental affairs. This option is largely based on the Environmental Resources Courses which has been running successfully for six years.

SECTION A

Introduction to the Environmental Resources Course, Central Option.

The aim of the Environmental Resources Course, Central Option, is to enable people from a broad range of professions within the general field of environmental affairs, to see something of the wider implications of their own work and that of others. During the Course it is hoped that candidates will synthesize a basic understanding of the complexities of environmental management, and that they will consequently be more able to make wise decisions in this general field. The area of study is very broad, and in an attempt to give some cohesion to the work, it has as a central theme the unstable biological conditions brought about by man-made modifications to the natural environment. Both rural and urban areas are studied and emphasis is placed on the unity of the environment rather than on the artificial divisions such as town and country; and farming and industry. The Course is given in part by the staff of the Department of Biology, but because of the wide range of topics covered, heavy reliance is placed on experts from outside the Department and the University. Speakers are drawn from local industry, Local Government, other Universities, The Forestry Commission, The Natural Conservancy Council, Regional Water Authorities and many other sources. By basing the Course within the Department of Biology and combining it with contributions to the option from experts outside the biological sciences, it is possible to provide candidates with a high standard of information, while at the same time giving them a definite academic home within the University. In addition to the programme of lectures and visits, many of the activities are so organised that candidates come together to work in small research teams. For this type of organisation to be successful, a strong corporate spirit is essential within the group as a whole. By basing the Course within one Department, and by making every attempt to build up a close contact between the Course tutors and the candidates, this sense of corporate identity is encouraged. Experience based on the first six years of the Course has shown that this approach has worked very well.

The option is divided into two parts. Two terms of formal teaching finishing in April, followed by dissertation work until the end of the Course in September. (Course members with no previous biological training will not be expected to acquire facility in such basic biological skills as dissection and section cutting.)

The scope of the Course is wide, but a substantial proportion of the formal teaching in the first term is devoted to a detailed study of marine and freshwater resources. Using the knowledge of aquatic resource problems as a basis, other environmental problems are covered later in the Course. Many problems in environmental affairs are essentially human problems and some of the speakers to the Course are selected to show how either individuals or specialist groups have surmounted environmental difficulties. It is not possible to view the problems of the environment solely in the context of today, and whenever possible the historical events leading to current situations are considered.

In addition to lectures, candidates for the degree are expected to read the extensive literature on the subject, and write at least three major essays on varied topics.

LECTURES AND DISCUSSIONS

a. Introductory Studies.

As the Course has a biological central theme, the first part of the programme is devoted to providing a basic understanding of biological principles

and relating these to environmental affairs. This period of the Course is aimed at the non biologists, but experience has shown that it is also useful to most candidates with a biological background, as it enables them to start the process of linking their specialist biological knowledge to general environmental affairs.

This part of the Course is made up of 12 lectures plus discussion periods. Approximate time: 20 hours.

(A special one week crash course in biology is available before the start of the M.Sc. Course for non biologists.)

b. Freshwater and Marine Studies.

During this section of the Course, the aquatic habitats are considered in some detail, methods of resource management are considered and the effects of man's activities on the ecology of various aquatic habitats is considered.

SUBJECT

General freshwater ecology.

Pollution of fresh water.

Water supply and the management of freshwater resources. Including the work obligations and powers of River Authorities and Water Supply Boards. (Regional Water Authorities.)

Freshwater fisheries management.

Canals as a freshwater amenity and transport resource.

Marine oil pollution.

Methods of offshore waste disposal.

Problems of offshore waste disposal and the protection of coastal waters.

Estuarine ecology.

Management of wetland areas.

Management of coastal areas, both the coastline and offshore.

c. General Terrestrial Studies.

The study of the terrestrial environment is based on a number of general lectures which include:

SUBJECT

Geology as the basis of landscape.

Soil, its ecology and managment.

The ecology of sand dunes.

The ecology of woodlands.

The ecology of grassland.

The ecology of mountains.

On the foundation of these special studies, various applications of terrestrial environmental management are discussed. These include:

Forestry.

Agricultural practice.

Pesticides and their alternatives.

Reclamation of derelict land.

Public pressure on the rural environment i.e. erosion caused by recreation.

Landscape architecture.

Open cast mining, its impact and cosmetic repair.

d. Health and Disease as an Environmental Factor.

In both advanced and developing countries, health is an important factor. Many health problems are closely linked to environmental factors. For instance in underdeveloped countries, three important vector borne diseases, malaria, sleeping sickness and river blindness often exert critical influences on many aspects of human endeavour. In this section of the Course, health aspects of environmental affairs are discussed. In a Course based in the United Kingdom and staffed mainly by people with a training based in temperate countries, it is difficult to obtain expert teaching on conditions overseas. The Biology Department at Salford is fortunate in having staff who have very considerable experience in tropical medicine. This section of the Course is concerned, therefore, not only with vector borne disease in tropical countries, but it is also used to try to draw attention to the fact that tropical areas can differ in many fundamental ways from temperate areas. In addition to a discussion of health problems overseas, this part of the Course also contains lectures on health and environmental protection in large cities in temperate areas, and an introduction to the important field of environmental control and health within industry.

e. General Studies.

Many aspects of environmental affairs do not fall easily into the categories listed previously. They are included in this section headed general studies. Many of these subjects are of critical importance in the study of environmental affairs:

The Conservation of Nature: The need for the conservation of natural resources. The work of the Nature Conservancy, and the newly formed Nature Conservancy Council. The management of nature reserves. The keeping of biological records and the monitoring of changes in the natural environment.

6 lectures + visits — 16 hours.

Countryside Management: Under this title, various pressures on the Countryside are discussed, much of this part of the Course is covered by visits to areas of interest, for instance national and country parks, forest parks, and field study centres. Urban parks and conservation areas and their amenity use as an alternative to the use of rural areas.

Visits and lectures 8-16 hours.

General Pollution Studies: Some aspects of pollution are covered in the sections outlined above. In this section air pollution, noise in the environment, waste disposal and the recycling of waste are discussed.

6 lectures + visits — 14 hours.

Population, Ethical and Aesthetic Studies. Estimates of world population, nutritional requirements of man, and the future availability of food; sociological and political implications of environmental control; aesthetic consideration in environmental management; design; marketing and resource husbandry.

16 lectures — 32 hours.

General Studies: The work of voluntary organisations in environmental protection; industry and the environment; industrial archeology and the history of attempts at environmental management; the work of planners and specialist agencies in the environmental field; the development of cities; the city environment and transportation.

13 lectures — 26 hours.

Special Courses: A special course is available for candidates with no knowledge of statistics. This course provides an introduction to statistical methods. It also provides an introduction to the possibility of using computers in environmental work. Courses on the techniques of computer use are available to all postgraduates at the University of Salford.

GROUP PROJECTS

Throughout the first two terms, candidates are arranged into groups to investigate specific environmental situations in the locality. In addition to providing useful information on areas such as derelict sites, the Dee Estuary, the River Mersey and its estuary, local canals and fishery problems, this part of the Course provides a valuable opportunity for candidates to participate as a member of a research team. Apart from any academic benefit this has, it also ensures that Course members have an opportunity to appreciate the complexities of team organisation, logistics and group report writing.

TUTORIALS

Tutorials are arranged for small groups of candidates at approximately fortnightly intervals. During tutorials, various aspects of environmental affairs are discussed, and opportunities are provided for a free interchange of ideas on topics not covered in the lecture programme.

SEMINARS

Class discussions are held from time to time throughout the Course. Candidates are allocated topics to research and present, or are encouraged to prepare items of individual specific interest. This exercise has been highly valued by course members, and it provides an opportunity to practise lecture preparation and presentation.

ESSAYS

In the first term, each candidate is expected to write one 5,000 word essay which is an individual piece of work. This essay is selected from a list of five titles. In addition, each candidate is expected to contribute to the

production of a joint paper in association with other people working on the same topic. This combined effort is later presented for the rest of the Course for discussion. During the second term, each course member is expected to write at least two additional essays on other subjects taken from a long list of titles which is available before the Christmas break.

FILMS

Throughout the Course, a selection of films relevant to the current timetable is provided to highlight particular topics and promote discussion. Films are mixed blessings and candidates are given an opportunity to see both good and indifferent examples.

FIELD COURSES

In addition to day visits to places of environmental interest, there is a residential field course in each term. The organisation of these courses varies slightly from year to year, and the first term field course was an innovation in the 1973/74 session. This takes the form of a long weekend within the first few weeks of the term, and it will probably continue to be held in the Lake District. The field course in the second term lasts for 7-10 days, and is either a tour or a long stay in a residential centre in Wales.

APPENDIX III: Sketch of a course on environmental problems for psychology students at Lund University

The problems of siting a nuclear power plant used as theme.

1. *Confrontation period* Field work for 1-2 days involving short interviews with workers in the plant, people living near it e.g. fishermen, people in summer houses, farmers, owner of the village shop etc. Interviews with experts from the company operating the plant, regional and local planning officials etc.

2. *Discussion and specification of needs for knowledge.*

   Students and staff define and delimit certain problems identified during "1" for further study and specify the needs for lecture courses and readings relevant to these problems.

3. *Study period.*

   A series of short lecture courses (3-5 weeks) on some of the main topics identified in "2". Examples of such courses would be available and certain of them perhaps be required. (In which case "1" serves as motivation and the discussion in "2" is limited to this and to planning the details of these courses.)

   Ex "radiation biology"; "physical planning processes"; "waste problems of nuclear power plants"; "social geography"; "work environment problems".

4. *Group work.*

   Parallel to and after "3" a study of some of the problems identified is carried out in small groups. The results are presented at seminars with members of the groups of people most concerned with the particular problem studied and with experts from outside the University.

PUBLICATIONS OF THE COUNCIL FOR CULTURAL CO-OPERATION

In the same section - Higher Education and Research

EDUCATION IN EUROPE

The teaching of physics at university level (1967)
Publications on sale (publ. by G. Harrap, London):
The teaching of geography at university level (1968)
The teaching of economics at university level (1970)
The teaching of mathematics at university level (1970)
The screening of students (1970)

COMPANION VOLUMES

Non-university research centres and their links with the universities (1967)
Reform and expansion of higher education in Europe (1967)
European research resources: Assyriology (1967)
European research resources: Radio-chemistry (nuclear chemistry) (1967)
European research resources: Geography (1968)
European research resources: Radio-astronomy (1968)
European research resources: Photochemistry (1970)
Mobility of University Staff (1973)
Reforms and new trends in medical untergraduate education (1973)
Distant study systems (1974)
Diversification of tertiary education (1974)

SALES AGENTS FOR PUBLICATIONS OF THE COUNCIL OF EUROPE

AUSTRIA
Gerold & Co.
Graben 31
Vienna, 1

CANADA
Information Canada
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Nörregade 6
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Place Broglie